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SAVINGS REPORT FOR THE FORT HOOD ARMY BASE

A Research Project for the U.S. Army C.E.R.L.
and the Ft. Hood Energy Office

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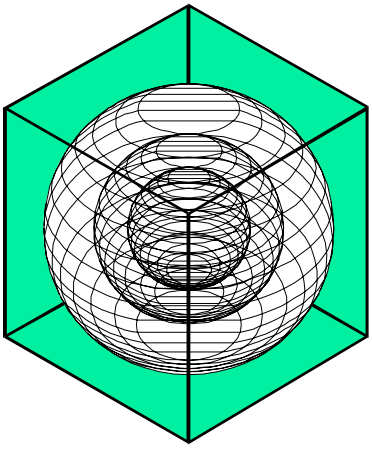

ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
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PREFACE

This report is the 2005 savings report for a multi-year Research Project performed for the U.S. Army Construction Engineering Research Laboratory, and the Ft. Hood Energy Office. This project was carried out in several phases. The first phase included the development of a Preliminary Monitoring and Analysis Plan (PreMAP), and the purchase and the installation of data monitoring equipment, which was delivered in the Spring of 2001. In 2001, additional data loggers were installed in the main and west-base electrical substations, and a steam/temperature channel was installed in the thermal plant. Installation of the III Corp building was also initiated in November of 2001 and completed in 2002.

In this report, the measured data from the thermal plant, buildings located in the 87000 block, III Corp building and other buildings that were determined to be part of the ESPC project at Ft. Hood are analyzed for pre- and post-retrofit periods. The electricity consumption and electric demand savings resulting from the retrofits completed in these sites are also calculated and reported in this report.

A CDROM has been prepared to accompany this savings report that contains all data collected at Ft. Hood from January 2003 to October 2005, the modeling and savings analysis files for each site, and the tools used for the savings analysis, that is, ASHRAE 1050 RP and ASHRAE 1093 RP reports and software.

ABSTRACT

This report presents electricity consumption and electric demand savings analysis for the Thermal Plant, buildings located in the 87000 block, III Corp building and other buildings that were determined to be part of the ESPC project at Ft. Hood, a total of 21 sites. The savings analysis for the Thermal Plant is not completed due to lack of post-retrofit data and will be included in the report upon receiving more data from Fort Hood.

The data used for savings calculations were collected through the synergistic loggers installed at the Thermal Plant and III Corp building and portable loggers attached to Watt-hour meters in selected buildings. For each site, the hourly data collected for the pre- and post periods are converted to daily usage and then modeled with ASHRAE's IMT change-point linear models. The electricity consumption savings is then calculated for the months post-retrofit data are available. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, combined with ASHRAE's IMT change-point linear models, are used to evaluate demand savings.

In Section 1 of the report, savings summaries for the sites measured and all the sites are given. In summary, the total measured savings of 1,034,473 kWh for the measured period corresponds to 60.7% of the audit-estimated electricity savings. The total of the measured demand savings of 1,220 kW for the measured period corresponds to 37.2% of the audit-estimated savings. Both measured electricity and demand savings fall short of expectations. The projected annual savings, which include the projected annual measured savings for the sites measured and the stipulated annual savings for the sites not measured, to match the JCI estimates for all the 57 sites, is also presented in Section 1. 78.2% of the audit-estimated electricity savings and 72.0% of the audit-estimated demand savings could be achieved assuming that the sites not measured were achieving 100% of the audit-estimated savings. The detailed savings summary and the plots showing the savings analysis for each site are presented in Sections 2 to 22.

An Appendix is also provided that includes the list of data files in the accompanying CDROM with this report.

ACKNOWLEDGEMENTS

This project would not have been possible without the support that was provided by Dave Schwenk (USACERL), David Underwood (USACERL), and Bobby Lynn, Danny Shaff and Myron Cook (Ft. Hood Energy Office). Thanks also to Ms. Sherrie Hughes for assistance ordering the ASHRAE reports, preparing the final report and CDROM, and sending the report. Thanks also to the following individuals who helped keep the computers running, the data flowing, and the printers printing at the ESL, including: Mr. Jim Sweeney and Mr. Stephen O'Neal. Thanks also to Ms. Shelly Price (SiTEX), and Mr. John McBride (NHT) who diligently installed the monitoring equipment under contract to the Energy Systems Laboratory (ESL). Thanks also to Mr. Kelly Milligan for assistance coordinating the metering equipment installation.

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1. SAVINGS SUMMARY

This section covers the savings summary for sites measured and for all sites. Table 1.1, Table 1.2 and Table 1.3 are the savings summaries from Table 1.4. As shown in Table 1.1, the audit-estimated electricity savings of the 20 measured sites were 1,704,712 kWh for the measured period. The audit-estimated demand savings of the 8 measured sites were 3,276 kW for the measured period. The total measured savings of 1,034,473 kWh for the measured period corresponds to 60.7% of the audit-estimated electricity savings (see Table 1.4). The total of the measured demand savings of 1,220 kW for the measured period corresponds to 37.2% of the audit-estimated savings (see Table 1.4). Both measured electricity and demand savings fall short of expectations.

Table 1.2 shows the projected annual savings based on measured savings to match the JCI estimates for the sites measured. The projected annual electricity savings of 1,707,134 kWh/yr correspond to 51.1% of the annual audit estimated savings for the sites measured (see Table 1.4). This is considered to be artificially low because of the projection method. The projected annual demand savings of 1,497 kW/yr correspond to 31.2% of the annual estimated savings for sites measured (see Table 1.4). If more data can be obtained for the post-retrofit period, the projected savings could approach 60.3% for electricity and 37.2% for demand as in the measured period.

Table 1.3 shows the projected annual savings to match the JCI estimates for all the 57 sites. The total projected annual savings include the projected annual measured savings for the sites measured and the stipulated annual savings for the sites not measured. 78.2% of the audit-estimated electricity savings and 72.0% of the audit-estimated demand savings could be achieved assuming that the sites not measured were achieving 100% of the audit-estimated savings (see Table 1.4).

Table 1.1. Total Measured Savings for Measured Sites during Measured Period

Electricity Savings For the Measured Period					Demand Savings For the Measured Period				
Total Building Area * (ft2)	No. Of Sites	Audit-Estimated Electricity Savings (kWh/period)	Measured Electricity Savings (kWh/period)	% of Audit-Estimated Savings	Total Building Area (ft2)	No. Of Sites	Audit-Estimated Demand Savings (kW/period)	Measured Demand Savings (kW/period)	% of Audit-Estimated Savings
922,087	20	1,704,712	1,034,473	60.7%	704,385	8	3,276	1,220	37.2%

*** The area of sites 33001, 33003, 18010 are not available and therefore not included in the table.**

Table 1.2. Total Projected Annual Savings for Sites Measured

Total Projected Annual Electricity Savings For the Measured Sites					Total Projected Annual Demand Savings For the Measured Sites				
Total Building Area * (ft2)	No. Of Sites	Audit-Estimated Electricity Savings (kWh/yr)	Projected Measured Electricity Savings (kWh/yr)	% of Audit-Estimated Savings	Total Building Area (ft2)	No. Of Sites	Audit-Estimated Demand Savings (kW/yr)	Projected Measured Demand Savings (kW/yr)	% of Audit-Estimated Savings
922,087	20	3,339,990	1,707,134	51.1%	704,385	8	4,794	1,497	31.2%

Table 1.3. Total Projected Annual Savings for All Sites (Measured and Stipulated)

Total Projected Annual Electricity Savings for All Sites					Total Projected Annual Demand Savings for All Sites				
Total Building Area * (ft2)	No. Of Sites	Audit-Estimated Electricity Savings (kWh/yr)	Projected Electricity Savings (kWh/yr)	% of Audit-Estimated Savings	Total Building Area (ft2)	No. Of Sites	Audit-Estimated Demand Savings (kW/yr)	Projected Demand Savings (kW/yr)	% of Audit-Estimated Savings
1,849,611	57	7,498,771	5,865,915	78.2%	1,849,611	57	11,782	8,485	72.0%

Table 1.4 shows the detailed savings summary for each site. The cells in Green are the measured savings sites that were evaluated in this report. The cells in Yellow are the sites where some measured data or manual reading data are available, but the savings could not be calculated because either pre-retrofit or post-retrofit data are missing. The cells in White are the sites where no measured or manual reading data exist for pre- and post-retrofit periods. The savings for site 87018 is currently stipulated because ESL is waiting for more data to complete the savings analysis.

In Table 1.4, columns 1 to 3 show the site number, building name and building size. Columns 4 to 6 show the total projected annual electricity savings for each site, including audit-estimated electricity savings (kWh/yr), projected electricity savings (kWh/yr), and % of the audit estimated savings. Columns 7 to 9 show the total projected annual demand savings for each site, including audit-estimated demand savings (kW/yr), projected demand savings (kW/yr), and % of the audit estimated savings. Columns 10 to 13 cover the measured electricity savings for the measured period, including number of days in the period, audit-estimated electricity savings (kWh/period), measured electricity savings (kWh/period), and % of the audit estimated savings. Columns 14 to 17 cover the measured demand savings for the measured period, including number of months in the period, audit-estimated demand savings (kW/period), measured demand savings (kW/period), and % of the audit estimated savings.

Due to the lack of post-retrofit data for most of the sites, an accurate post-retrofit model could not be developed. Therefore, the projected annual measured savings were estimated based on the average daily electricity savings and average monthly demand savings for the measured period. The average daily electricity savings for each site were calculated by dividing the total measured savings by the total number of days in the measured period, i.e., column 12 divided by column 10. Then, the projected annual measured electricity savings (column 5) for each site were estimated by multiplying the measured average daily energy savings by 365 days. The average monthly demand savings for each site were calculated by dividing the total measured savings by the total number of months in the measured period, i.e., column 16 divided by column 14. Then, the projected annual measured demand savings for each site were estimated by multiplying the measured average monthly demand savings by 12 months.

As seen in columns 6 and 9 of Table 1.4, credits were given for the sites not measured by assuming 100% of audit-estimated savings were achieved. The second to last row of the table shows the total projected measured annual savings and measured savings for the measured period for the sites measured. The last row of the table shows the total projected annual savings for all sites. This includes the projected annual measured savings for the sites measured and the stipulated annual savings for the sites not measured.

Table 1.4 Savings Summary for Measured Site and All Sites

Bldg. #	Building Name	Building Size (ft2)	Total Projected Annual Electricity Savings			Total Projected Annual Demand Savings			Electricity Savings For the Measured Period				Demand Savings For the Measured Period			
			Audit-Estimated Electricity Savings (kWh/yr)	Projected Electricity Savings (kWh/yr)	% of Audit-Estimated Savings	Audit-Estimated Demand Savings (kW/yr)	Projected Demand Savings (kW/yr)	% of Audit-Estimated Savings	No. Of Days	Audit-Estimated Electricity Savings (kWh/period)	Measured Electricity Savings (kWh/period)	% of Audit-Estimated Savings	No. Of Months	Audit-Estimated Demand Savings (kW/period)	Measured Demand Savings (kW/period)	% of Audit-Estimated Savings
87017	DINING FACILITY	15,695	41,390	61,985	149.8%	89	89	100.0%	28	3,175	4,755	149.8%				
87018	PHYSICAL PLANT **	3,327	522,971	522,971	100.0%	15	15	100.0%								
87008	BN HQ BLDG	6,371	18,412	28,327	153.8%	70	70	100.0%	28	1,412	2,173	153.8%				
87010	PHYSICAL FITNES	23,631	98,108	98,108	100.0%	172	172	100.0%								
87003	BN HQ BLDG & OR	12,314	51,320	53,342	103.9%	146	146	100.0%	14	1,968	2,046	103.9%				
87009	BN HQ BLDG & OR	12,381	49,190	35,979	73.1%	162	162	100.0%	28	3,773	2,760	73.1%				
87006	HEALTH CLINIC	4,073	11,047	9,646	87.3%	44	44	100.0%	28	847	740	87.3%				
87005	BDE HQ BLDG	9,840	26,450	31,833	120.4%	114	72	63.2%	14	1,015	1,221	120.4%	1	9	6	63.2%
9212	PATTON'S INN	1,612	13,221	13,221	100.0%	53	53	100.0%								
52019	COMANCHIE ACTIV	13,450	196,510	196,510	100.0%	108	108	100.0%								
42000	SPORTS USA	23,341	406,107	406,107	100.0%	92	92	100.0%								
6602	BRONCO YOUTH CE	22,100	85,034	85,034	100.0%	125	125	100.0%								
5485	PERSHING YOUTH	17,519	34,329	34,329	100.0%	68	68	100.0%								
85018	WALKER YOUTH CE	15,652	50,954	50,954	100.0%	113	113	100.0%								
194	NCO CLUB (PHANT)	19,023	511,903	511,903	100.0%	47	47	100.0%								
5764	OFFICERS CLUB	36,649	319,596	319,596	100.0%	152	152	100.0%								
22020	ADMIN	21,096	195,943	195,943	100.0%	180	180	100.0%								
52024	COMANCHE CHILD	34,779	376,866	261,223	69.3%	217	288	132.8%	100	103,251	71,568	69.3%	4	72	96	132.8%
1001	Headquarters Building	312,800	821,700	787,465	95.8%	2,363	1,382	58.5%	365	821,700	787,465	95.8%	12	2,363	1,382	58.5%
91002	HEADQUARTERS	38,462	218,137	98,423	45.1%	121	96	79.5%	115	68,728	31,010	45.1%	4	40	32	79.5%
91014	ADMIN (HENSON H)	26,224	162,590	162,590	100.0%	184	184	100.0%								
91012	ADMIN (STONE HA)	86,292	391,136	-189,531	-48.5%	388	18	4.6%	110	117,877	-57,119	-48.5%	4	129	6	4.6%
410	HEADQUARTERS BU	102,391	931,344	258,400	27.7%	1,025	-559	-54.5%	202	515,428	143,005	27.7%	7	598	-326	-54.5%
87016	CO HQ BUILDING	25,168	50,197	84,341	168.0%	157	157	100.0%	14	1,925	3,235	168.0%				
87011	CO HQ BUILDING	25,618	55,680	34,479	61.9%	157	157	100.0%	28	4,271	2,645	61.9%				
87019	CO HQ BUILDING	18,818	33,628	33,628	100.0%	126	126	100.0%								
87004	CO HQ BUILDING	18,818	46,779	46,779	100.0%	126	126	100.0%								
87014	CO HQ BUILDING	14,162	32,892	54,940	167.0%	96	44	45.8%	25	2,253	3,763	167.0%	3	24	11	45.8%
4351	MOTOR POOL	16,317	25,314	25,314	100.0%	75	75	100.0%								
30015	MOTOR POOL	20,240	63,486	63,486	100.0%	218	218	100.0%								
38014	MOTOR POOL	20,240	50,299	50,299	100.0%	183	183	100.0%								
38003	MOTOR POOL	20,240	64,908	64,908	100.0%	247	247	100.0%								
35014	MOTOR POOL	20,480	52,109	52,109	100.0%	191	191	100.0%								
30033	MOTOR POOL	20,240	69,343	69,343	100.0%	256	256	100.0%								
35023	MOTOR POOL	23,040	41,741	41,741	100.0%	135	135	100.0%								
30017	MOTOR POOL	20,240	58,581	58,581	100.0%	219	219	100.0%								
15060	MOTOR POOL	20,240	83,276	83,276	100.0%	329	329	100.0%								
19012	MOTOR POOL	20,240	0	0		150	150	100.0%								
9553	MOTOR POOL	24,560	40,097	40,097	100.0%	140	140	100.0%								
9535	MOTOR POOL	20,240	67,860	67,860	100.0%	260	260	100.0%								
9513	MOTOR POOL	20,832	90,926	90,926	100.0%	362	362	100.0%								
9127	MOTOR POOL	20,240	58,304	58,304	100.0%	222	222	100.0%								
9122	MOTOR POOL	20,832	117,344	117,344	100.0%	477	477	100.0%								
9112	MOTOR POOL	20,832	106,906	106,906	100.0%	431	431	100.0%								
87015	ENLISTED UPH	42,306	6,502	-18,229	-280.3%	3	3	100.0%	17	303	-849	-280.3%				
87012	ENLISTED UPH	42,306	9,719	29,329	301.8%	5	5	100.0%	17	453	1,366	301.8%				
87021	ENLISTED UPH	87,021	6,523	6,523	100.0%	1	1	100.0%								
87007	ENLISTED UPH	31,470	5,887	-6,763	-114.9%	0	0		17	274	-315	-114.9%				
87013	ENLISTED UPH	31,740	6,439	6,439	100.0%	0	0									
87022	ENLISTED UPH	42,306	23,936	23,936	100.0%	54	54	100.0%								
85020	COMMISARY	105,659	165,961	36,107	21.8%	470	156	33.2%	26	11,822	2,572	21.8%	1	39	13	33.2%
28000	1ST CAV	129,635	300,217	300,217	100.0%	0	0									
33001	MEDAC		38,406	118,212	307.8%	138	138	100.0%	212	22,307	68,660	307.8%				
33003	MEDAC		37,754	-62,374	-165.2%	126	126	100.0%	212	21,928	-36,228	-165.2%				
18010 *																
36014			101,674	101,674	100.0%	303	303	100.0%								
87020	ENLISTED UPH	42,306	38,111	38,111	100.0%	79	79	100.0%								
50012	Community Events	4,203	13,713	13,713	100.0%	0	0									
Total for Measured Sites		**922,087**	**3,339,990**	**1,707,134**	**51.1%**	**4,794**	**1,497**	**31.2%**		**1,704,712**	**1,034,473**	**60.7%**		**3,276**	**1,220**	**37.2%**
Total for All Sites		**1,849,611**	**7,498,771**	**5,865,915**	**78.2%**	**11,782**	**8,485**	**72.0%**								

*** This site is not included in the total numbers because the audit-estimated savings are not available.**

**** The stipulated savings are used in the table because the savings calculation is not completed for these sites.**

***** The audit-estimated savings for this site is from the JCI audit-estimated savings summary table used in 2003 baseline report.**

2. SAVINGS SUMMARY FOR 1001-THIRD CORP HEADQUARTERS BUILDING

This section covers the energy and demand savings report for 1001-Third Corp Headquarters of Fort Hood for the period of May 2004 – April 2005. According to the information obtained from Fort Hood, only the lighting retrofit was implemented at this site. The project was completed on April 16, 2004. The audit-estimated savings were 821,700 kWh/yr for electricity and 2363 kW/yr for electrical demand. As shown in Table 2.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings is simply the annual savings divided by twelve. The electricity savings of 787,465 kWh/yr correspond to 95.8% of the audit estimated savings. This indicates that the lighting retrofits are generally working as expected. However, the total of the monthly demand savings of 1,382 kW corresponds to 58.5% of the audit estimated savings. This falls short of expectations. This appears to begin in the beginning of 2005, which may indicate an operational change. Therefore, additional information is needed from Fort Hood to identify the reason(s) that demand savings are not meeting expectations.

Figure 2.1 shows the time series plot of the measured daily electricity use of 1001-Headquarters Building for the period April 2003 through April 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models, as shown in Figure 2.2. The monthly electricity consumption for pre- and post-retrofit period and the electricity savings are presented in Figure 2.3.

The monthly electrical demand for pre- and post-retrofit period and the electrical demand savings are presented in Figure 2.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of May 2003 (Pre-retrofit) and May 2004 (Post-retrofit) are displayed in Figure 2.5 and Figure 2.6, as an example to present the demand savings analysis. The 90^{th} percentiles are used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for pre- and post period are 1177 kW and 1043 kW, respectively. Therefore, the savings for May 2004 is 134 kW.

The spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings are available upon request and will be included in the final report.

Table 2.1. Savings Summary for 1001

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
May-04	31	9,866	69,788	14.1%
Jun-04	30	42,592	67,537	63.1%
Jul-04	31	83,543	69,788	119.7%
Aug-04	31	81,526	69,788	116.8%
Sep-04	30	93,511	67,537	138.5%
Oct-04	31	115,744	69,788	165.9%
Nov-04	30	110,083	67,537	163.0%
Dec-04	31	83,406	69,788	119.5%
Jan-05	31	69,998	69,788	100.3%
Feb-05	28	45,293	63,035	71.9%
Mar-05	31	42,503	69,788	60.9%
Apr-05	30	9,400	67,537	13.9%
Total	**365**	**787,465**	**821,700**	**95.8%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
May-04	31	134.15	196.92	68.1%
Jun-04	30	98.18	196.92	49.9%
Jul-04	31	200.14	196.92	101.6%
Aug-04	31	126.60	196.92	64.3%
Sep-04	30	222.72	196.92	113.1%
Oct-04	31	158.77	196.92	80.6%
Nov-04	30	264.31	196.92	134.2%
Dec-04	31	135.66	196.92	68.9%
Jan-05	31	-16.26	196.92	-8.3%
Feb-05	28	-33.94	196.92	-17.2%
Mar-05	31	27.69	196.92	14.1%
Apr-05	30	64.19	196.92	32.6%
Total	**365**	**1,382**	**2,363**	**58.5%**

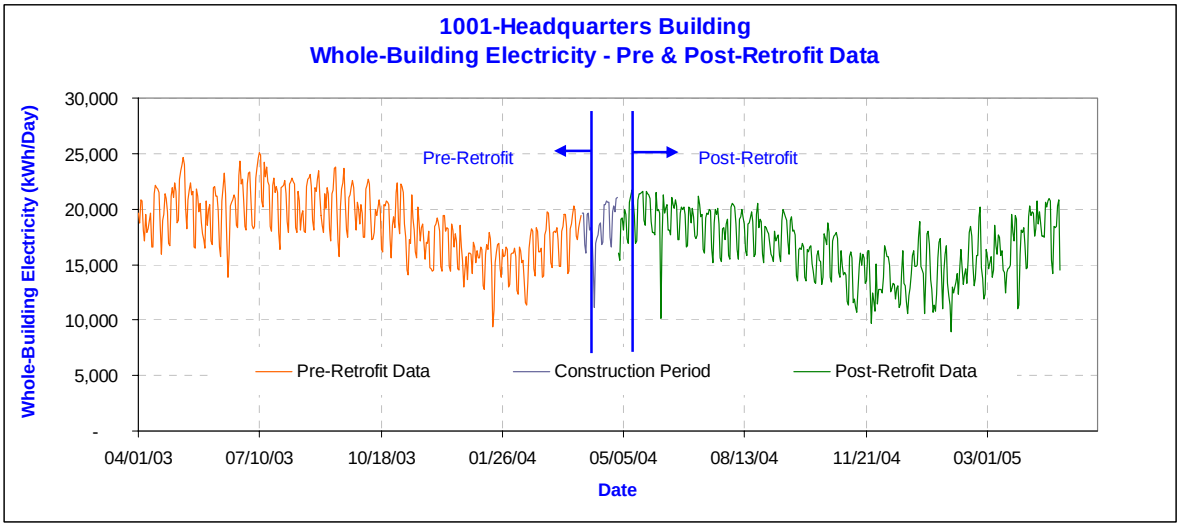

Figure 2.1 1001 Daily Electricity Use

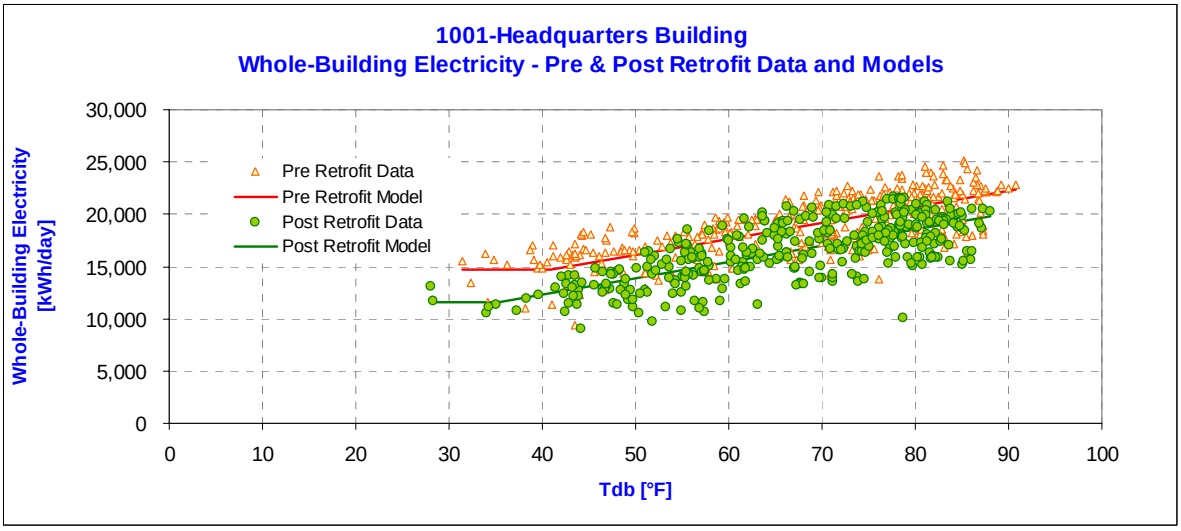

Figure 2.2 1001 Electricity Models for Pre- and Post-retrofit Periods

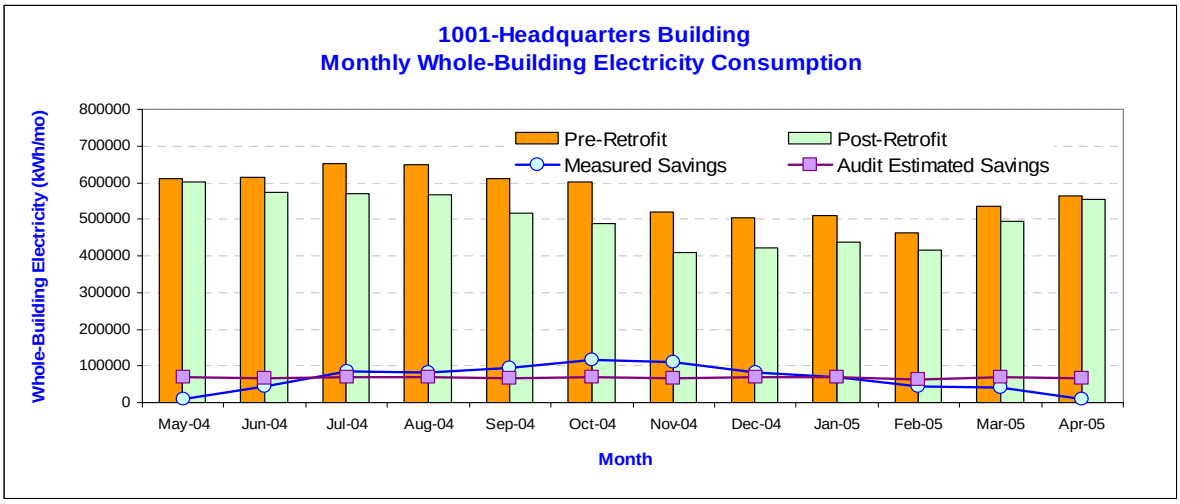

Figure 2.3 1001 Electricity Savings

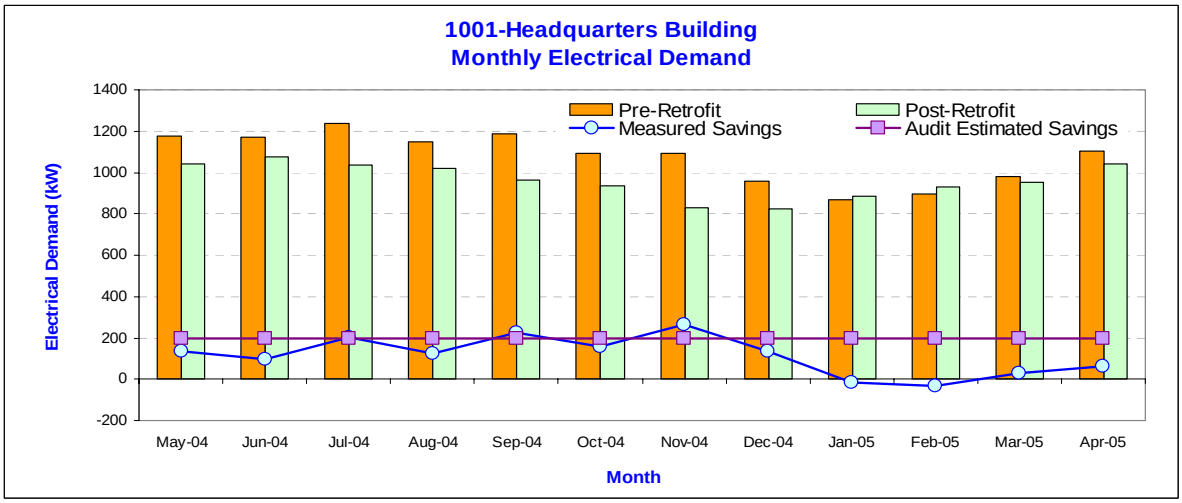

Figure 2.4. 1001 Electrical Demand Savings

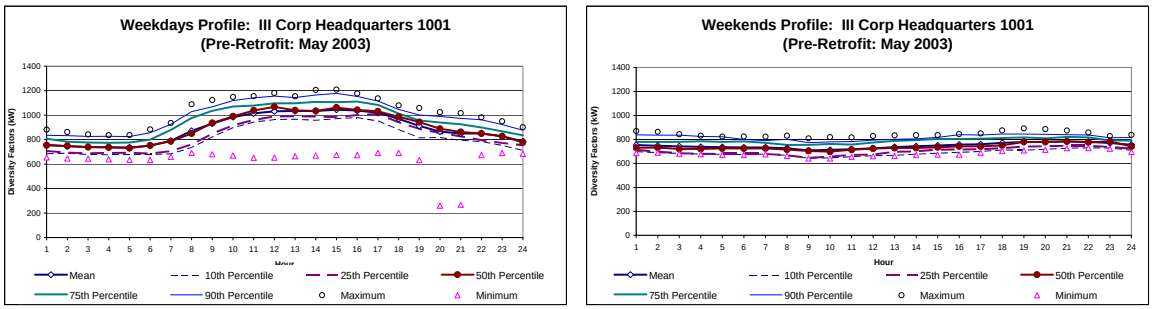

Figure 2.5. 1001 Electrical Demand Model for Pre-retrofit Period

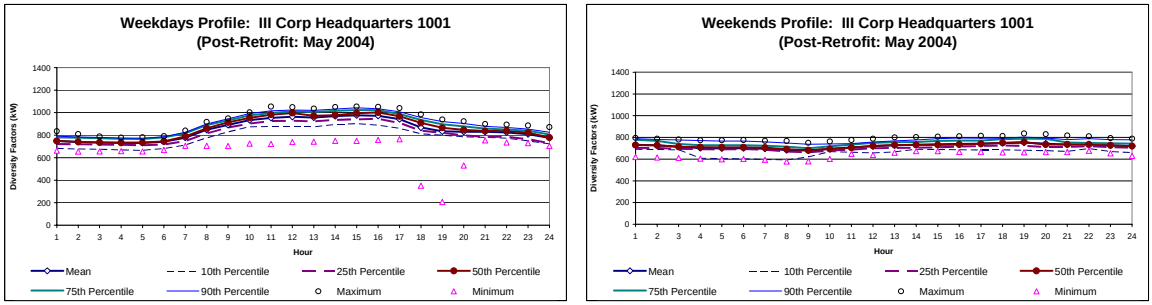

Figure 2.6. 1001 Electrical Demand Model for Post-retrofit Period

3. SAVINGS SUMMARY FOR 91012-ADMIN/OPERATIONAL TESTING BUILDING

This section covers the energy and demand savings report for 91012-Administration/Operational Testing Building of Fort Hood for the period of January 2005 – April 2005. According to the information obtained from Fort Hood, lighting and HVAC controls retrofits were implemented at this site. The lighting project was completed in March 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 391,136 kWh/yr for electricity and 388 kW/yr for electrical demand. As shown in Table 3.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings is simply the annual savings divided by twelve. The electricity savings of -57,119 kWh correspond to -48.5% of the audit estimated savings. The total of the monthly demand savings of 6 kW corresponds to 4.7% of the audit estimated savings. This falls short of expectations. The negative savings observed in January 2005 and February 2005 may indicate that there was an operational change. However, savings begin to show in April 2005 for electricity and March 2005 for electrical demand because of the HVAC control retrofit. Therefore, more data are needed from Fort Hood to continue monitoring the savings.

The comparison between manual reading data for the pre-retrofit period and ACR data for the same period showed that the ACR data were low compared to the audit-estimated savings data. Therefore, it is assumed that the manual reading data were correct and a scale factor of 30.39 was calculated for the ACR data to match the manual reading. Figure 3.1 shows the time series plot of the measured daily electricity use of 91012-Administration Building for the period of December 2002 through April 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models for weekdays and weekends separately, as shown in Figure 3.2. The monthly electricity consumption for pre- and post-retrofit period and the electricity savings are presented in Figure 3.3.

The monthly electrical demand for pre- and post-retrofit period and the electrical demand savings are presented in Figure 3.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of March 2002 (Pre-retrofit) and March 2005 (Post-retrofit) are displayed in Figure 3.5 and Figure 3.6, as an example to present the demand savings analysis. The 90^{th} percentiles are used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for pre- and post periods are 456 kW and 419 kW, respectively. Therefore, the savings for March 2005 is 36 kW.

The spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings are available upon request and will be included in the final report.

Table 3.1. Savings Summary for 91012

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jan-05	31	-33,541	33,220	-101.0%
Feb-05	28	-23,701	30,005	-79.0%
Mar-05	31	-4,244	33,220	-12.8%
Apr-05	20	4,367	21,432	20.4%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**110**	**-57,119**	**117,877**	**-48.5%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jan-05	31	-60.78	32.33	-188.0%
Feb-05	28	-30.39	32.33	-94.0%
Mar-05	31	36.47	32.33	112.8%
Apr-05	20	60.78	32.33	188.0%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**110**	**6**	**129**	**4.7%**

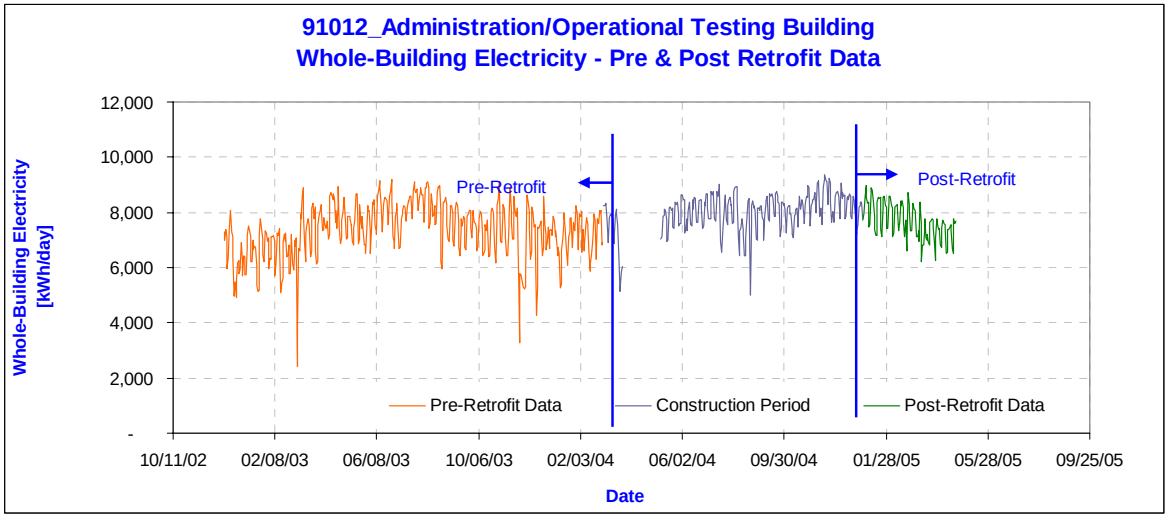

Figure 3.1 91012 Daily Electricity Use

Figure 3.2 91012 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

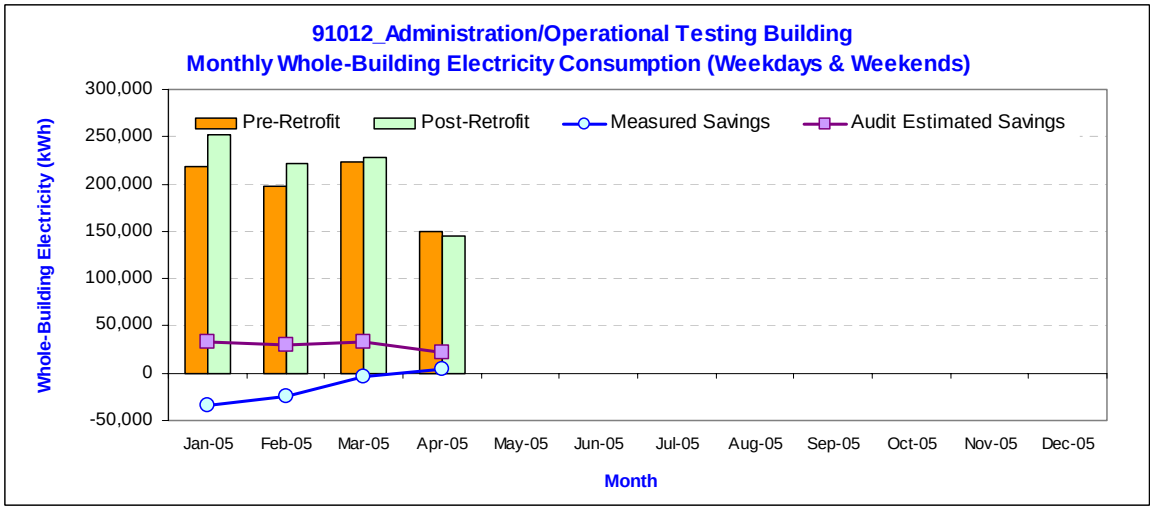

Figure 3.3 91012 Electricity Savings

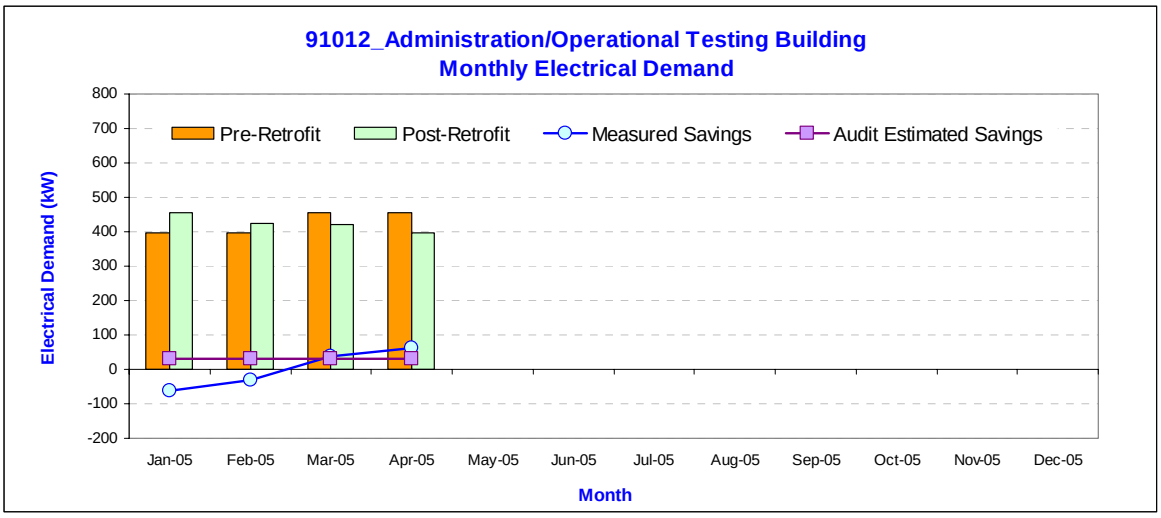

Figure 3.4. 91012 Electrical Demand Savings

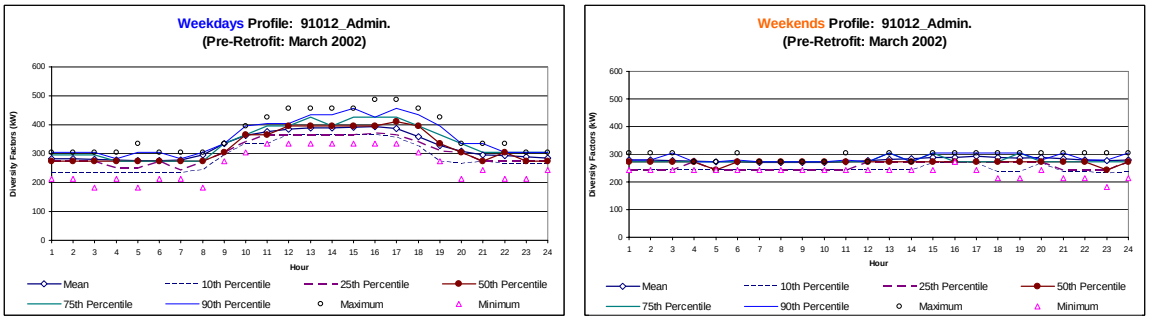

Figure 3.5. 91012 Electrical Demand Model for Pre-retrofit Period

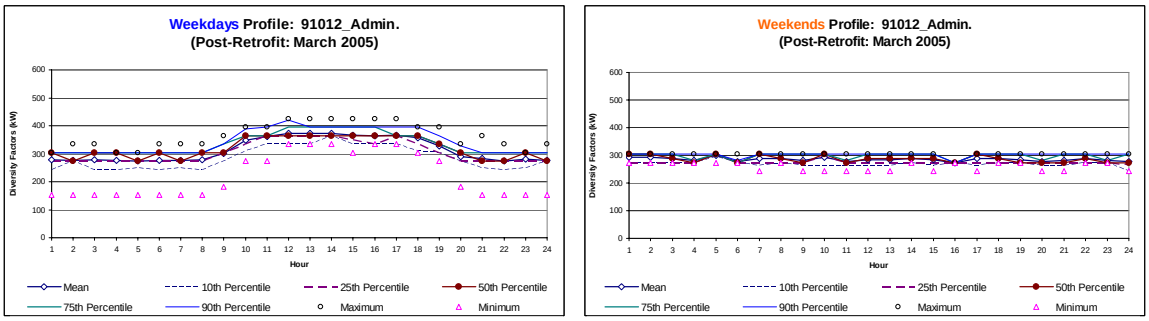

Figure 3.6. 91012 Electrical Demand Model for Post-retrofit Period

4. SAVINGS SUMMARY FOR 410-HEADQUARTERS BUILDING

This section covers the energy and demand savings report for 410-Headquarters Building of Fort Hood for the period of October 2004 – April 2005. According to the information obtained from Fort Hood, lighting, HVAC controls, and vending miser retrofits were implemented at this site. The lighting and vending miser projects were completed in March 2004 and the HVAC controls project was completed in September 2004. The audit-estimated savings were 931,344 kWh/yr for electricity and 1,025 kW/yr for electrical demand. As shown in Table 4.1 the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings is simply the annual savings divided by twelve. The measured electricity savings of 143,005 kWh correspond to 27.7% of the audit estimated savings. This falls short of expectations. The total of the monthly demand of -326 kW, corresponds to an increase in electrical demand for the building. The negative demand savings observed from October 2004 to April 2005, except December 2004, may indicate that there was an operational change in the building that needs to be identified. Therefore, additional information is needed from Fort Hood to identify the reason(s) that both electricity and demand savings are not meeting expectations. Additional measured data are also needed for the higher outdoor temperature conditions in order to get a more accurate savings analysis.

Figure 4.1 shows the time series plot of the measured daily electricity use of 410-Headquarters Building for the period of March 2003 to April 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The data for the period November 2003 to March 2004 were excluded in the analysis because it was felt that they were unreasonably low energy use, and no information was provided to explain the unusual low usage in this period. Including these data in the analysis will decrease the savings. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models for weekdays and weekends separately, as shown in Figure 4.2. The monthly electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 4.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 4.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of April 2003 (Pre-retrofit) and April 2005 (Post-retrofit) developed from measured data are displayed in Figure 4.5 and Figure 4.6, as an example to present the demand savings analysis. The maximum kW use of 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for April 2004 (pre-retrofit) and April 2005 (post-retrofit) are 329 kW and 400 kW, respectively. Therefore, the savings for April 2005 is -71 kW.

However, due to the missing data in the pre-retrofit period, in order to compare against the same months of post-retrofit period, ASHRAE's IMT change-point linear models were applied to extend the demand prediction from the 1093-RP demand savings analysis to months where no demand was available. As shown in Figure 4.7, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre-retrofit period. To accomplish this, a three parameter model (3PC) was chosen for the demand use model. Finally, the demand savings for the missing months was calculated by comparing the maximum demand from the 90^{th} percentile profile for the post-retrofit month against the estimated demand from the 3PC demand model for the corresponding pre-retrofit month.

The spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be delivered in the final report.

Table 4.1. Savings Summary for 410

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Oct-04	31	10,947	79,100	13.8%
Nov-04	30	2,557	76,549	3.3%
Dec-04	31	50,485	79,100	63.8%
Jan-05	31	34,942	79,100	44.2%
Feb-05	28	24,091	71,446	33.7%
Mar-05	31	16,463	79,100	20.8%
Apr-05	20	3,521	51,033	6.9%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Total	**202**	**143,005**	**515,429**	**27.7%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Oct-04	31	-111.20	85.42	-130.2%
Nov-04	30	-69.24	85.42	-81.1%
Dec-04	31	2.66	85.42	3.1%
Jan-05	31	-43.34	85.42	-50.7%
Feb-05	28	-20.94	85.42	-24.5%
Mar-05	31	-12.50	85.42	-14.6%
Apr-05	20	-71.00	85.42	-83.1%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Total	**202**	**-326**	**598**	**-54.4%**

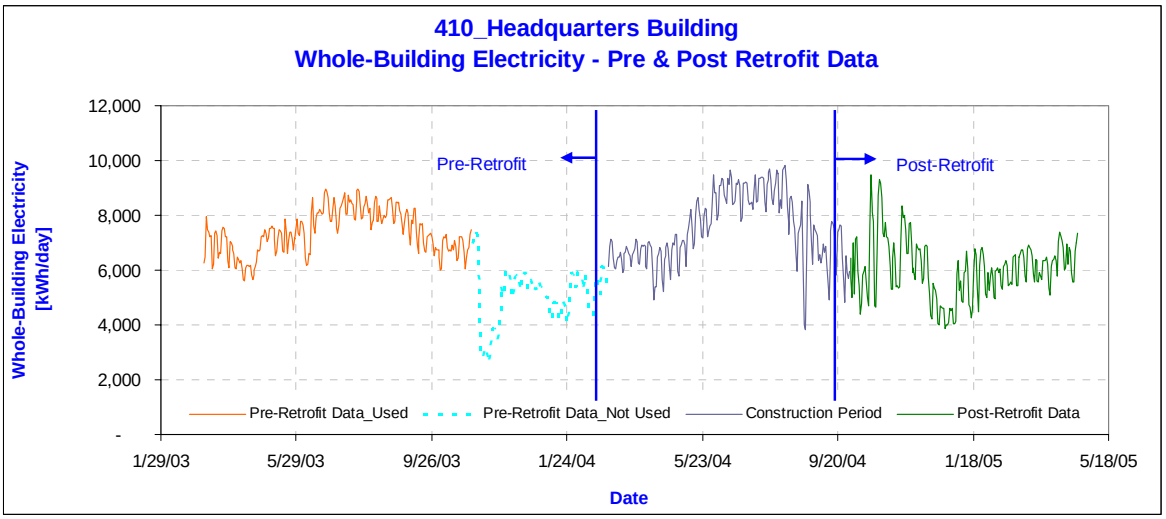

Figure 4.1. 410 Daily Electricity Use

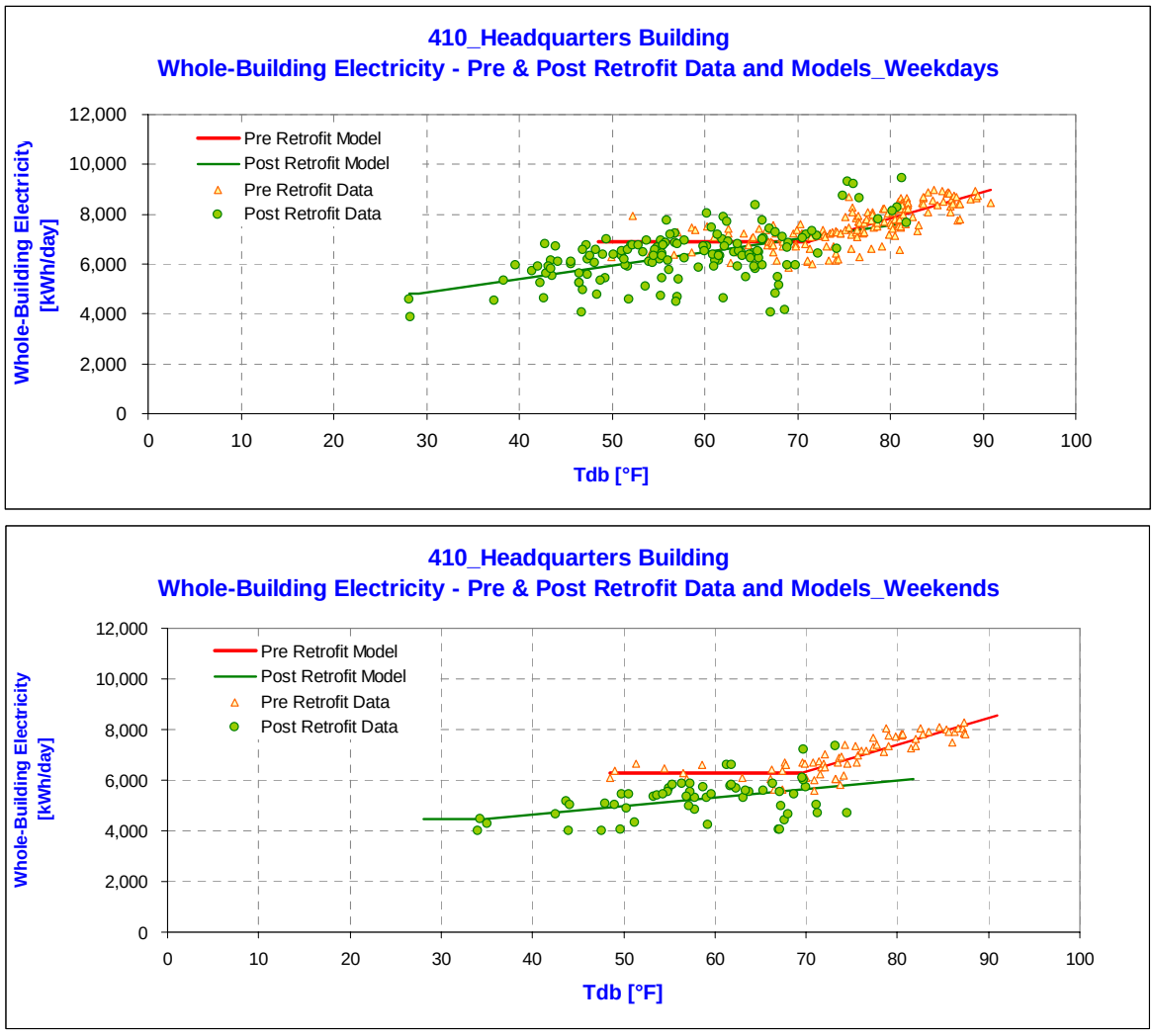

Figure 4.2. 410 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

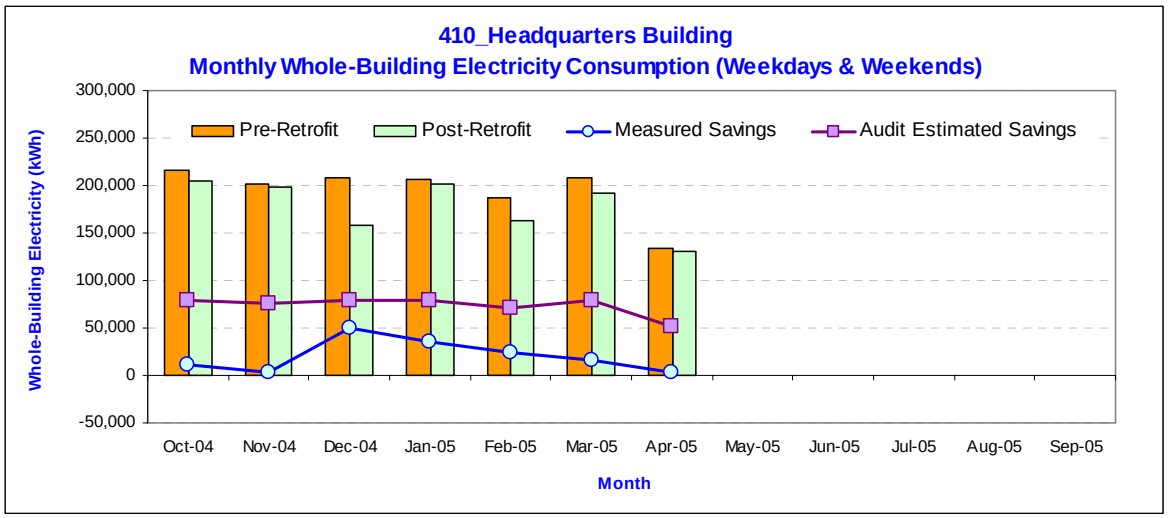

Figure 4.3. 410 Electricity Savings

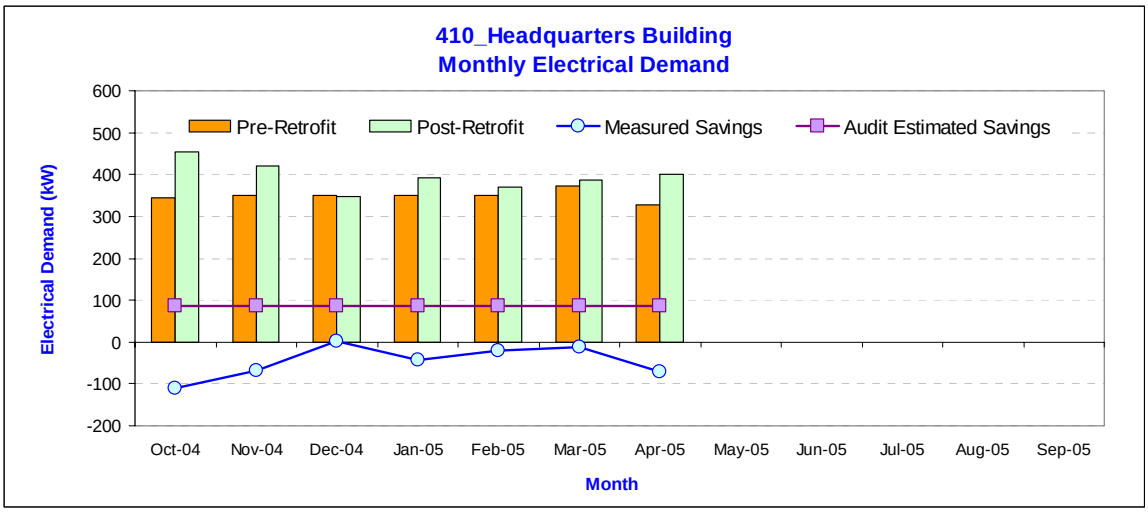

Figure 4.4. 410 Electrical Demand Savings

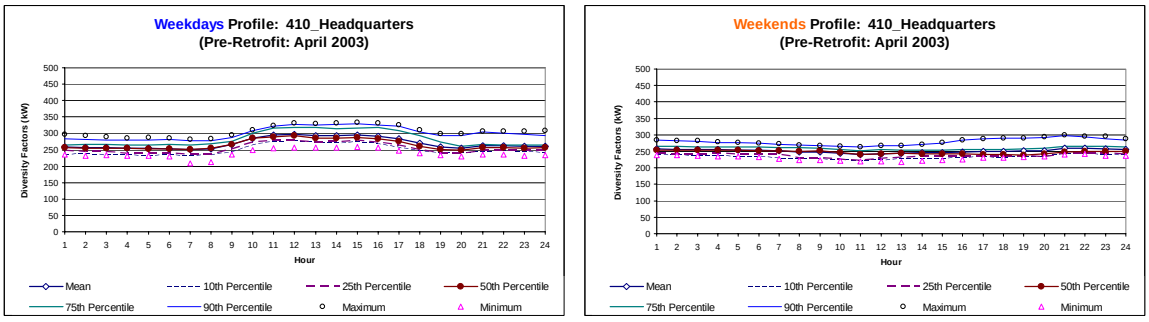

Figure 4.5. 410 Electrical Demand Model for Pre-retrofit Period

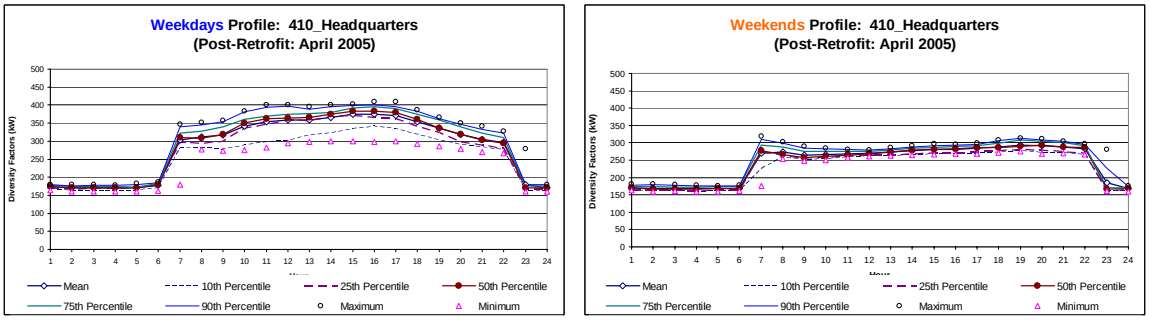

Figure 4.6. 410 Electrical Demand Model for Post-retrofit Period

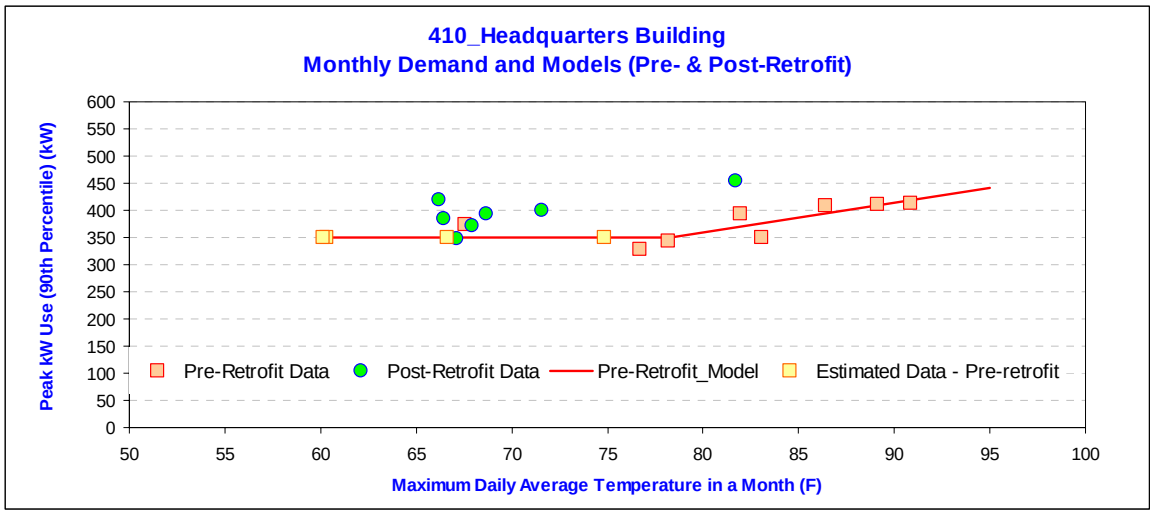

Figure 4.7. 410 Electrical Demand 3PC Model for Pre-retrofit Period

5. SAVINGS SUMMARY FOR 52024-COMANCHE CHILD

This section covers the energy and demand savings report for 52024-Comanche Child of Fort Hood for the period of December 2004 – March 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in May 2004 and the HVAC controls project was completed in November 2004. The audit-estimated savings were 376,866 kWh/yr for electricity and 217 kW/yr for electrical demand. As shown in Table 5.1 the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 71,568 kWh correspond to 69.3% of the audit estimated savings. The total of the measured monthly demand savings of 96 kW corresponds to 133.2% of the audit estimated savings. This indicates that the lighting retrofits are generally working as expected at this building. However, more energy use data are needed to identify the savings for the higher outdoor temperature conditions.

Figure 5.2 shows the time series plot of the measured daily electricity use of 52024-Comanche Child for the period of November 2002 to March 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The data for the period of December 2003 to March 2004 were excluded in the analysis because they appear to be unreasonably low and no information was provided to explain the unusual low usage in this period. If these data are included in the analysis it will lower the savings. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models, as shown in Figure 5.2. The monthly electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 5.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 5.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of December2003 (Pre-retrofit) and December 2004 (Post-retrofit) developed from measured data are displayed in Figure 5.5 and Figure 5.6, as an example to present the demand savings analysis. The maximum kW use of 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for December 2003 (Pre-retrofit) and December 2004 (Post-retrofit) are 140 kW and 159 kW, respectively. Therefore, the savings for December 2004 is 19 kW.

However, due to the missing data in the pre-retrofit period, in order to compare against the same months of post-retrofit period, ASHRAE's IMT change-point linear models were applied to extend the demand prediction from the 1093-RP demand savings analysis to months where no demand was available. As shown in Figure 5.7, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre-retrofit period. To accomplish this, a three parameter model (3PC) was chosen for the demand use model. Finally, the demand savings for the missing months was calculated by comparing the maximum demand from the 90^{th} percentile profile for the post-retrofit month against the estimated demand from the 3PC demand model for the corresponding pre-retrofit month.

The spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 5.1. Savings Summary for 52024

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Dec-04	31	28,629	32,008	89.4%
Jan-05	31	21,275	32,008	66.5%
Feb-05	28	17,451	28,910	60.4%
Mar-05	10	4,214	10,325	40.8%
Apr-05				
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Total	**100**	**71,568**	**103,251**	**69.3%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Dec-04	31	19.20	18	106.2%
Jan-05	31	17.22	18	95.2%
Feb-05	28	17.72	18	98.0%
Mar-05	10	42.20	18	233.4%
Apr-05				
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Total	**100**	**96**	**72**	**133.2%**

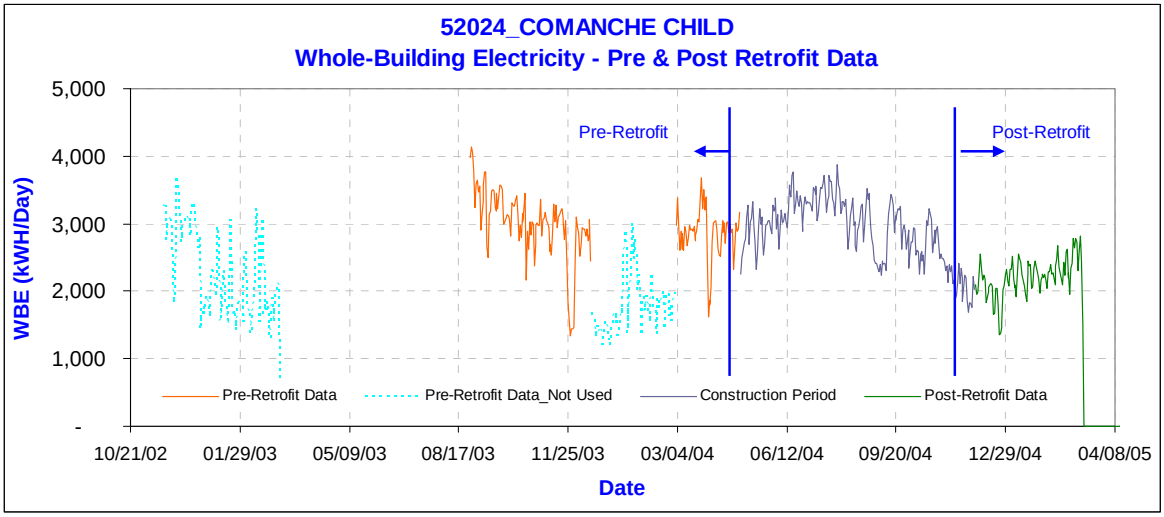

Figure 5.1. 52024 Daily Electricity Use

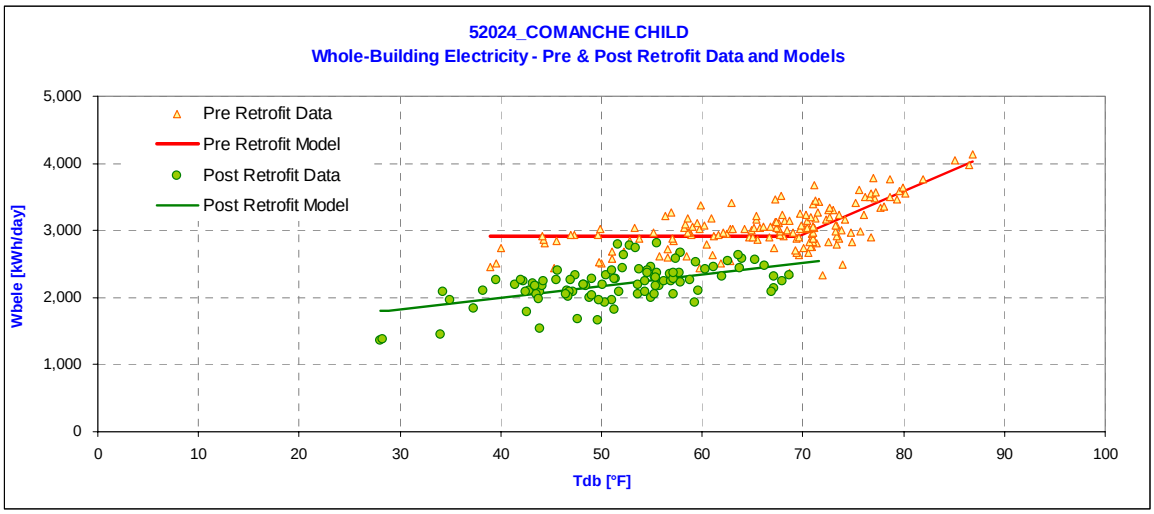

Figure 5.2. 52024 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

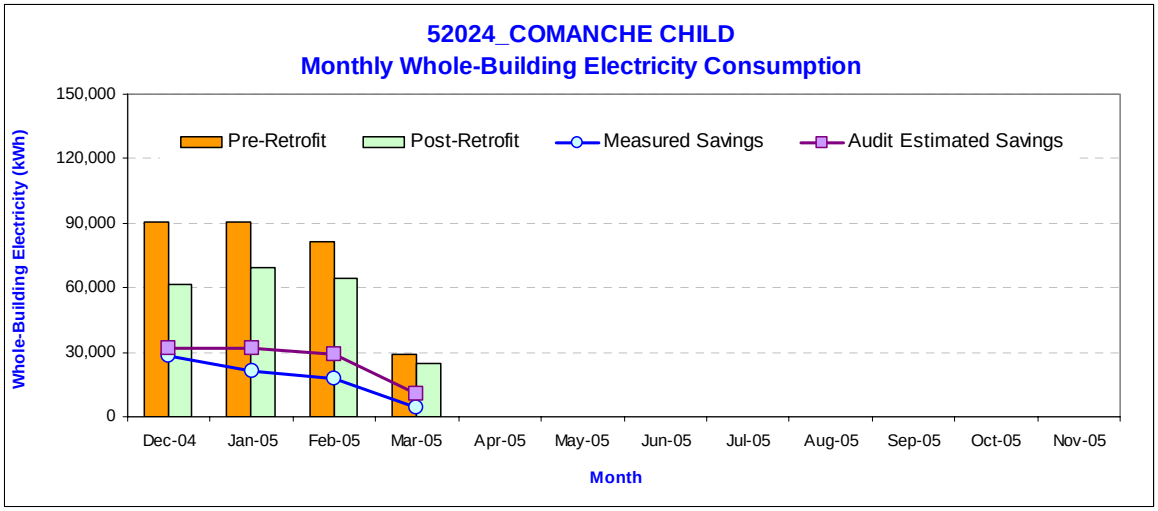

Figure 5.3. 52024 Electricity Savings

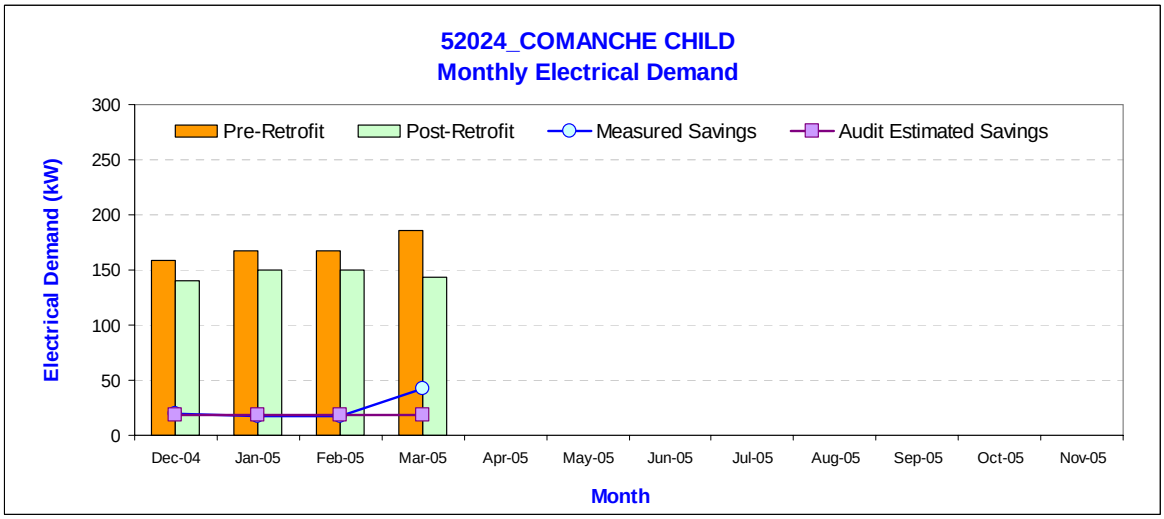

Figure 5.4. 52024 Electrical Demand Savings

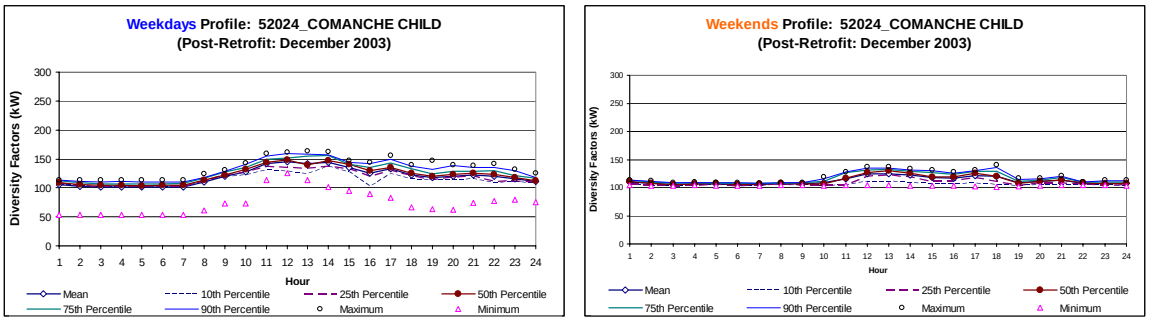

Figure 5.5. 52024 Electrical Demand Model for Pre-retrofit Period

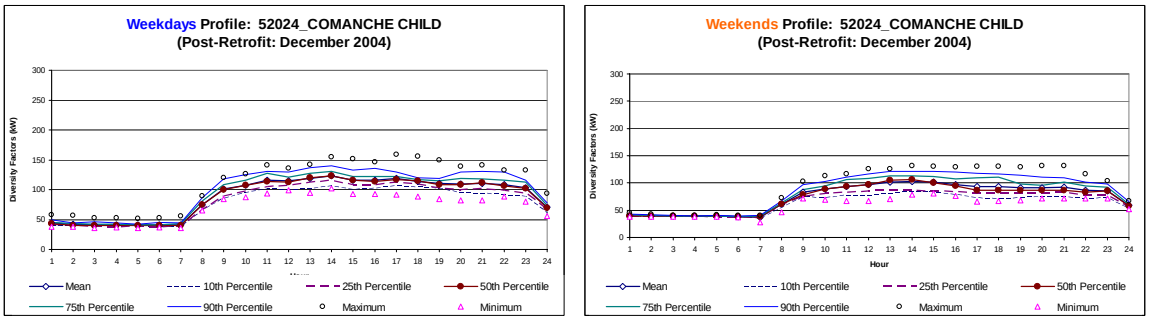

Figure 5.6. 52024 Electrical Demand Model for Post-retrofit Period

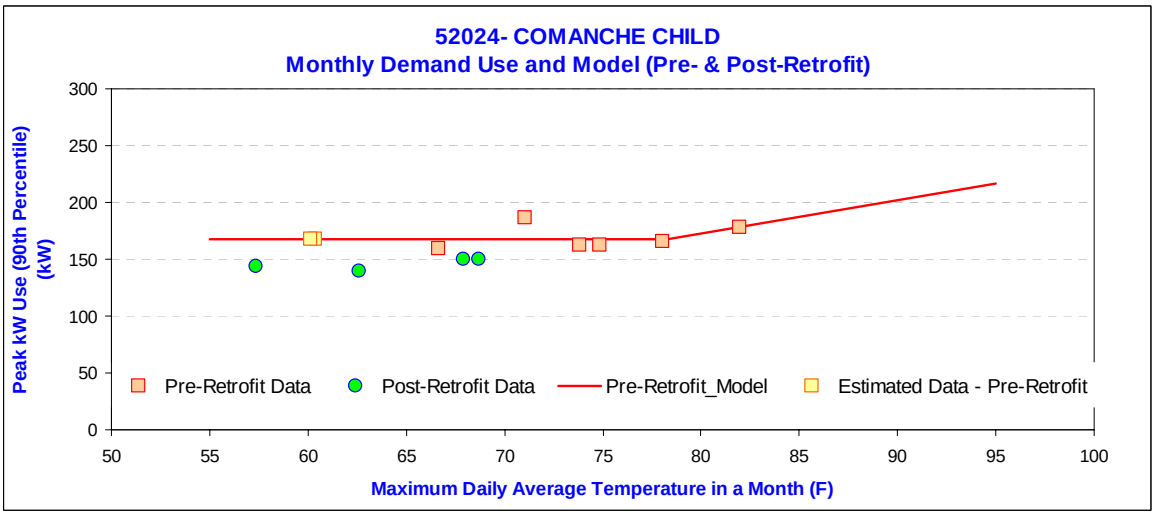

Figure 5.7. 52024 Electrical Demand 3PC Model for Pre-retrofit Period

6. SAVINGS SUMMARY FOR 91002-HEADQUARTERS BUILDING

This section covers the energy and demand savings report for 91002-Headquarters Building of Fort Hood for the period of January 2005 – April 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in March 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 218,137 kWh/yr for electricity and 121 kW/yr for electrical demand. As shown in Table 6.1, the monthly audit estimated savings for electricity is proportional to the number of days per month, and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 31,010 kWh correspond to 45.1% of the audit estimated savings. The total of the measured monthly demand savings of 32 kW corresponds to 79.8% of the audit estimated savings. This indicates that the lighting retrofits are generally working as expected at this building. However, more energy use data are needed to identify the savings for the higher outdoor temperature conditions.

Figure 6.1 shows the time series plot of the measured daily electricity use of 91002-Headquarters Building for the period of September 2003 to April 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models for weekdays and weekends separately, as shown in Figure 6.2. The monthly electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 6.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 6.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of January 2004 (Pre-retrofit) and January 2005 (Post-retrofit), developed from measured data, are displayed in Figure 6.5 and Figure 6.6, as an example to present the demand savings analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for January 2004 (Pre-retrofit) and January 2005 (Post-retrofit) are 88 kW and 82 kW, respectively. Therefore, the savings for January 2005 is 6 kW.

However, due to the missing data in the pre-retrofit period, in order to compare against the same months of post-retrofit period, ASHRAE's IMT change-point linear models were applied to extend the demand prediction from the 1093-RP demand savings analysis to months where no demand was available. As shown in Figure 6.7, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre-retrofit period. To accomplish this, a one parameter model (1P = average model) was chosen for the demand use model. Finally, the demand savings for the missing months was calculated by comparing the maximum demand from the 90^{th} percentile profile for the post-retrofit month against the estimated demand from the 1P demand model for the corresponding pre-retrofit month.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 6.1. Savings Summary for 91002

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jan-05	31	8,381	18,527	45.2%
Feb-05	28	8,211	16,734	49.1%
Mar-05	31	7,714	18,527	41.6%
Apr-05	25	6,705	14,941	44.9%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**115**	**31,010**	**68,728**	**45.1%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jan-05	31	6.10	10.08	60.5%
Feb-05	28	5.30	10.08	52.6%
Mar-05	31	8.38	10.08	83.1%
Apr-05	25	12.38	10.08	122.8%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**115**	**32**	**40**	**79.8%**

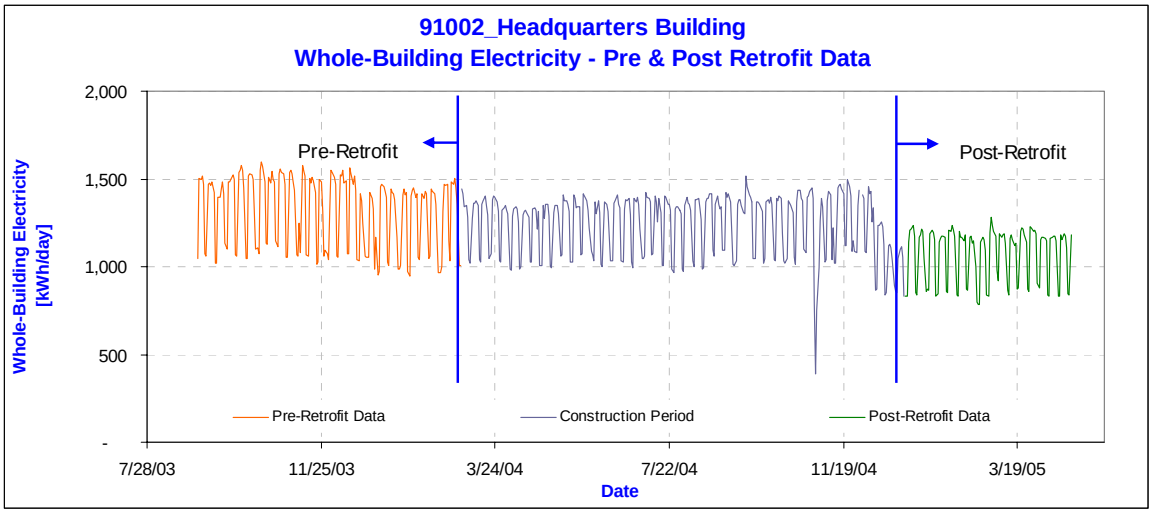

Figure 6.1. 91002 Daily Electricity Use

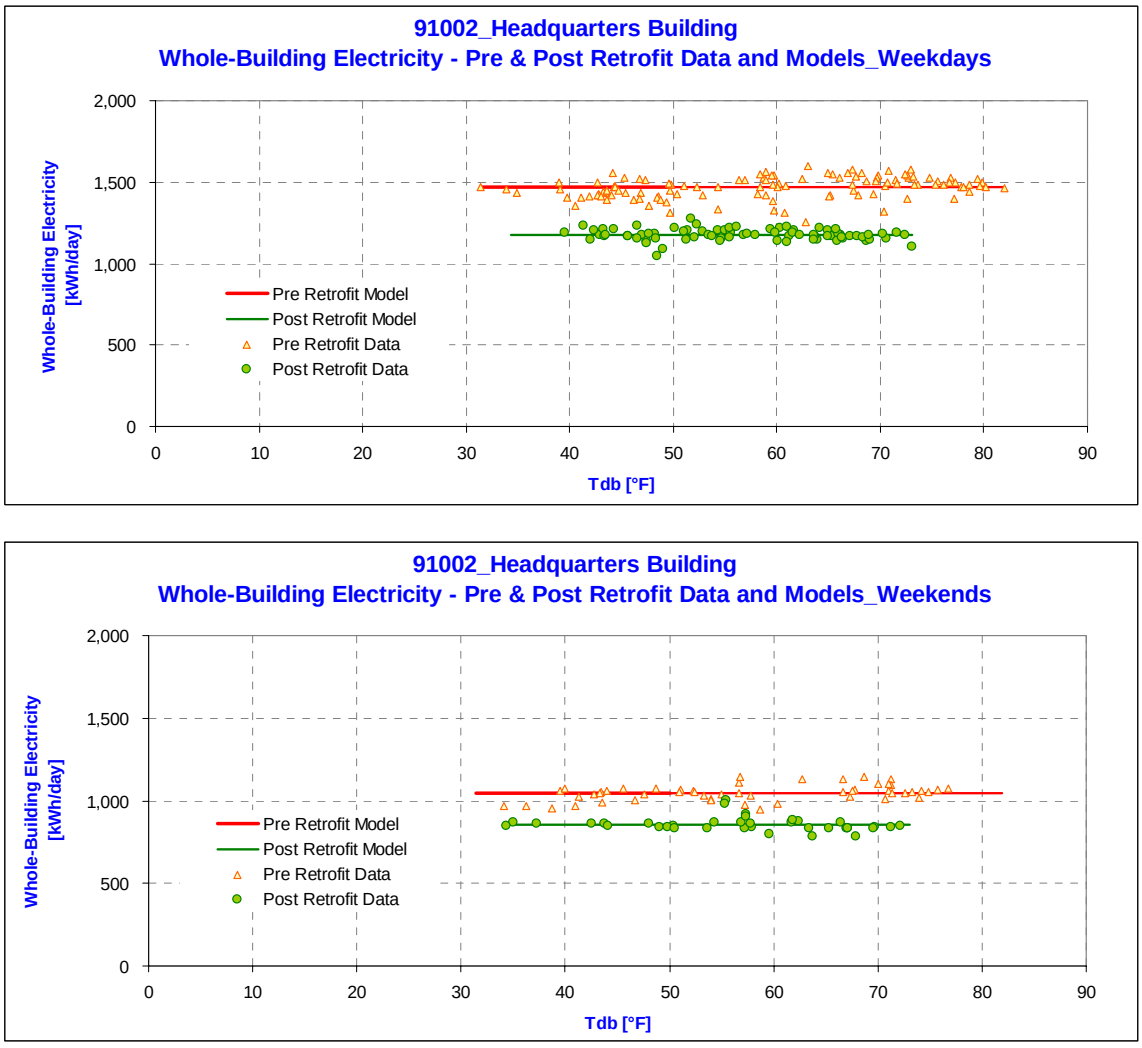

Figure 6.2. 91002 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

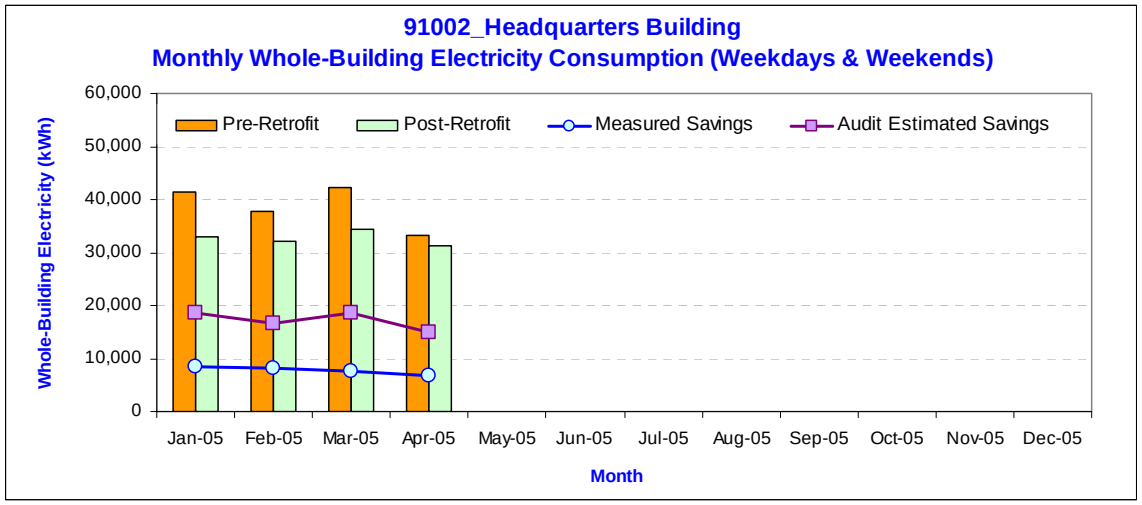

Figure 6.3. 91002 Electricity Savings

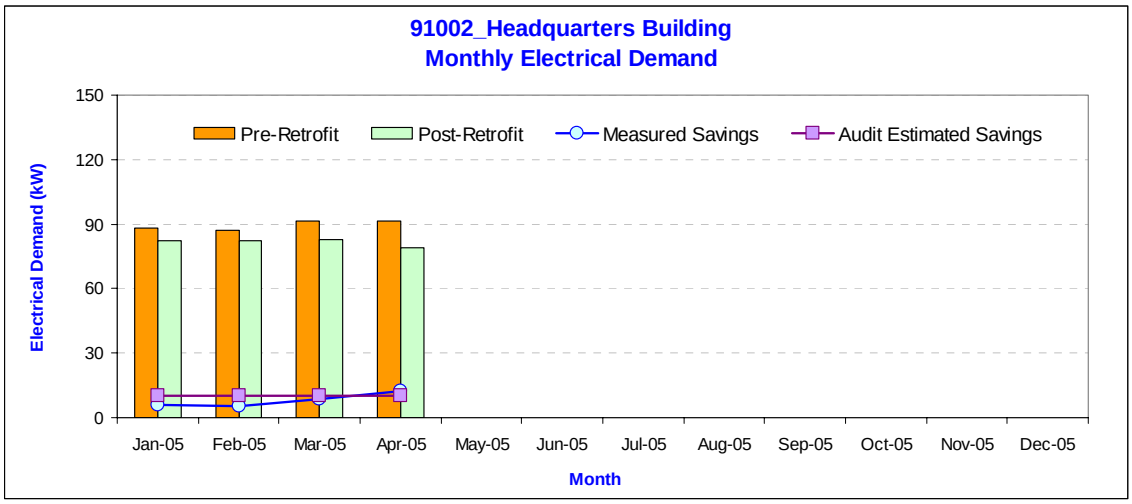

Figure 6.4. 91002 Electrical Demand Savings

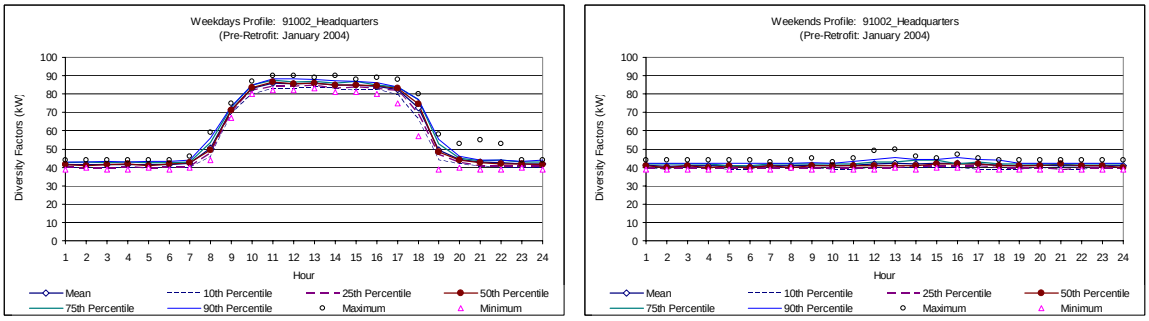

Figure 6.5. 91002 Electrical Demand Model for Pre-retrofit Period

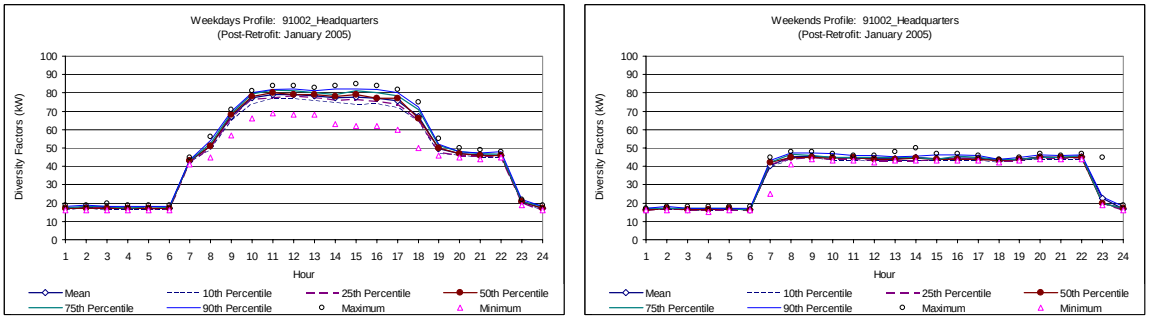

Figure 6.6. 91002 Electrical Demand Model for Post-retrofit Period

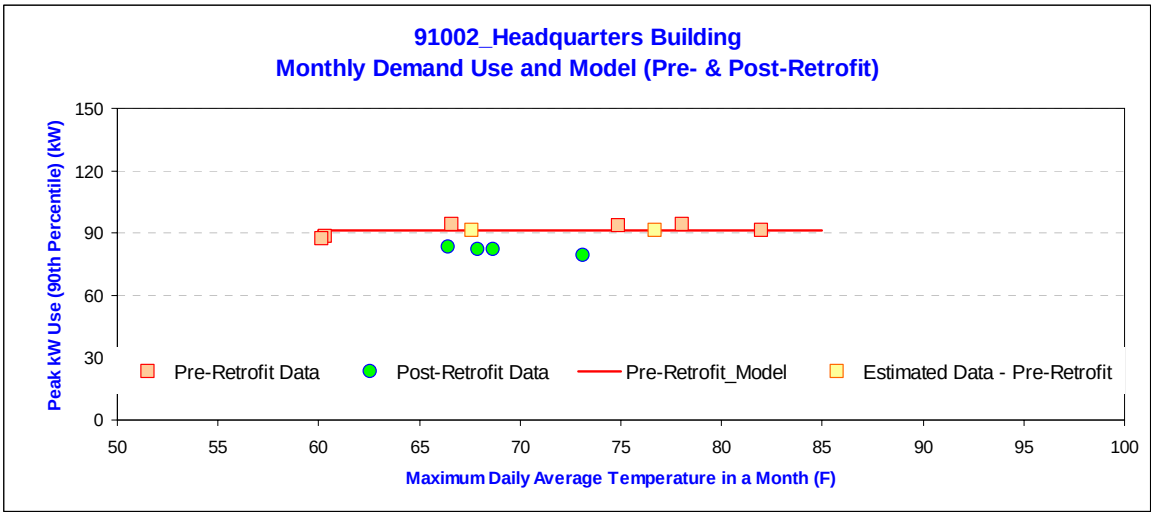

Figure 6.7. 91002 Electrical Demand 1P Model for Pre-retrofit Period

7. SAVINGS SUMMARY FOR 85020-COMMISSARY BUILDING

This section covers the energy and demand savings report for 85020-Commissary Building of Fort Hood for April 2005. According to the information obtained from Fort Hood, vending miser and HVAC controls were implemented at this site. The vending miser project was completed in February 2004 and the HVAC controls project was completed in March 2005. The audit-estimated savings were 165,961 kWh/yr for electricity and 470 kW/yr for electrical demand. As shown in Table 7.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,572 kWh correspond to 21.8% of the audit estimated savings. The total of the measured monthly demand savings of 13.19 kW corresponds to 33.7% of the audit estimated savings. Additional information is needed from Fort Hood to identify the reason(s) that both electricity and demand savings are not meeting expectations. More measured data are also needed for the higher outdoor temperature conditions in order to get a more accurate savings analysis.

Figure 7.1 shows the time series plot of the measured daily electricity use of 85020-Commisary Building for the period of May 2003 to April 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The hourly data collected for the pre- and post periods were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models, as shown in Figure 7.2 . The monthly electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 7.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 7.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of May 2003 (Pre-retrofit) and April 2005 (Post-retrofit), developed from measured data, are displayed in Figure 7.5 and Figure 7.6, as an example to present the demand savings analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for May 2003 (Pre-retrofit) and April 2005 (Post-retrofit) are 475 kW and 402 kW, respectively.

However, due to the missing data in the pre-retrofit period, in order to compare against the same months of post-retrofit period, ASHRAE's IMT change-point linear models were applied to extend the demand prediction from the 1093-RP demand savings analysis to months where no demand was available. As shown in Figure 7.7, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre-retrofit period. To accomplish this, a three parameter model (3PC) was chosen for the demand use model. Finally, the demand savings for the missing months was calculated by comparing the maximum demand from the 90^{th} percentile profile for the post-retrofit month against the estimated demand from the 3PC demand model for the corresponding pre-retrofit month. For example, in Figure 7.7, the estimated demand for April 2003 is 415 kW. Therefore, the demand savings for April 2005 is 13 kW.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 7.1. Savings Summary for 85020

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Apr-05	26	2,572	11,822	21.8%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Total	**26**	**2,572**	**11,822**	**21.8%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Apr-05	26	13.19	39.17	33.7%
May-05				
Jun-05				
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Total	**26**	**13**	**39**	**33.7%**

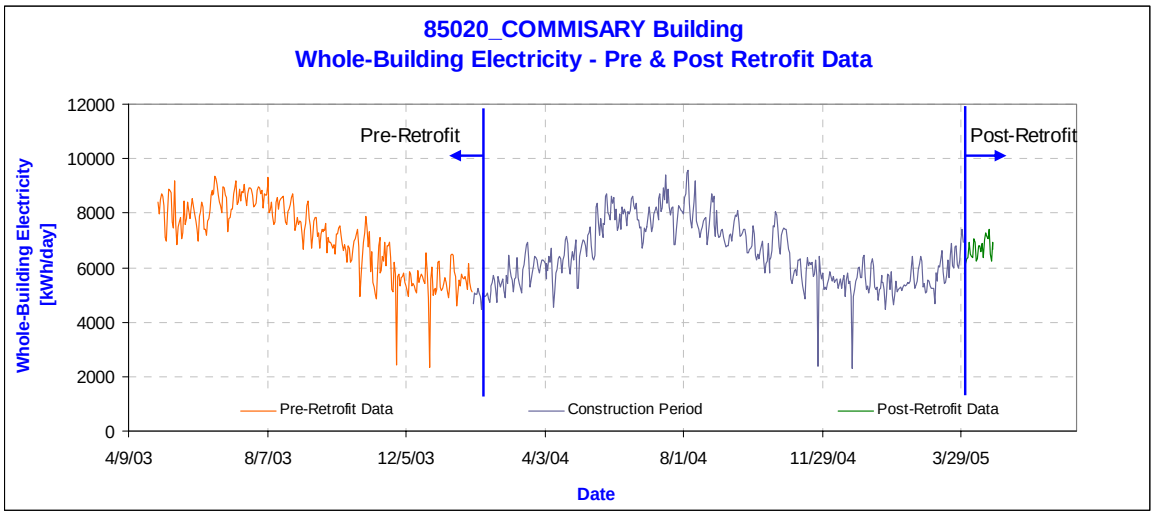

Figure 7.1. 85020 Daily Electricity Use

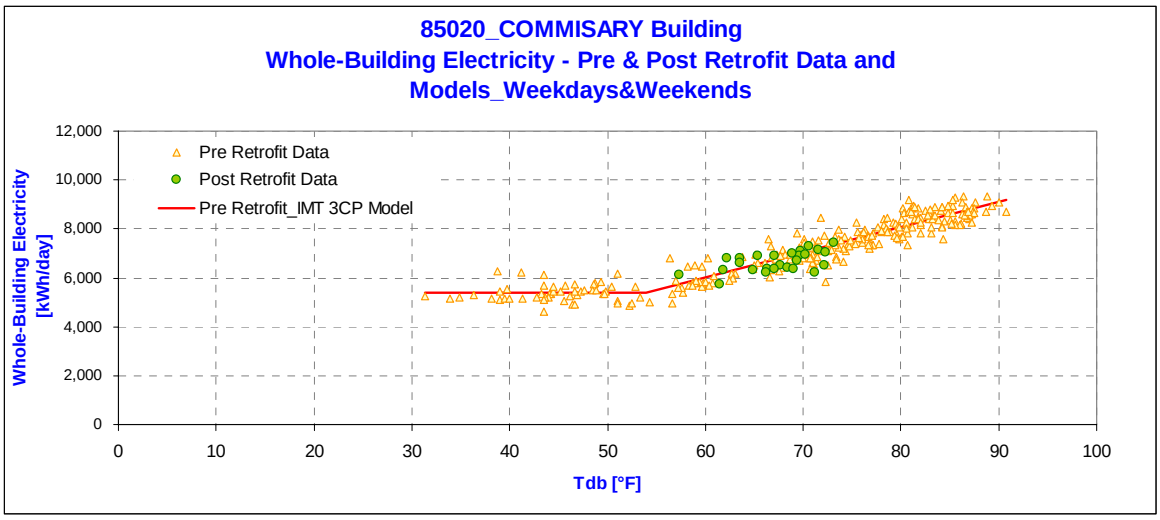

Figure 7.2. 85020 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

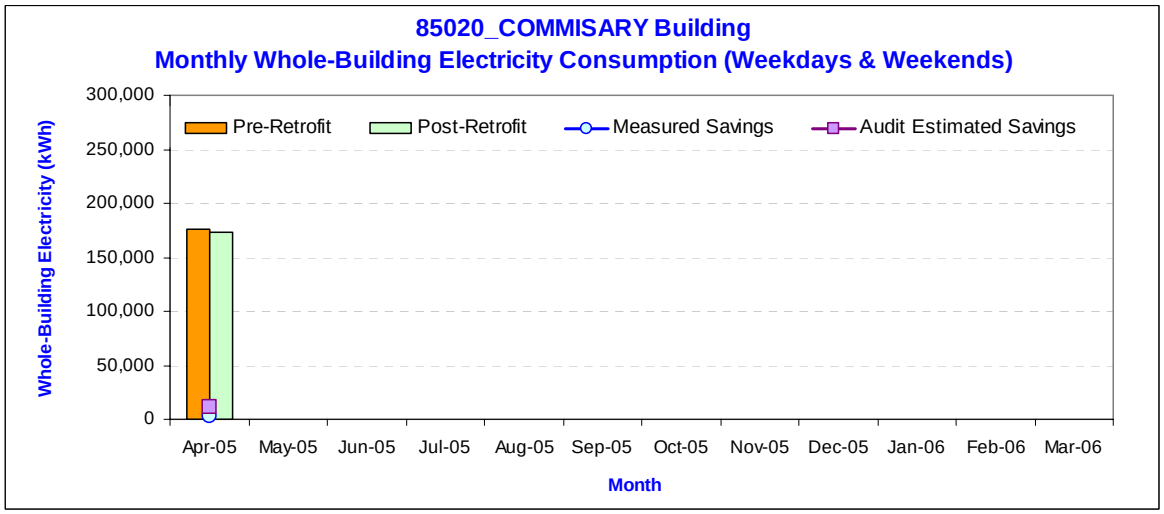

Figure 7.3. 85020 Electricity Savings

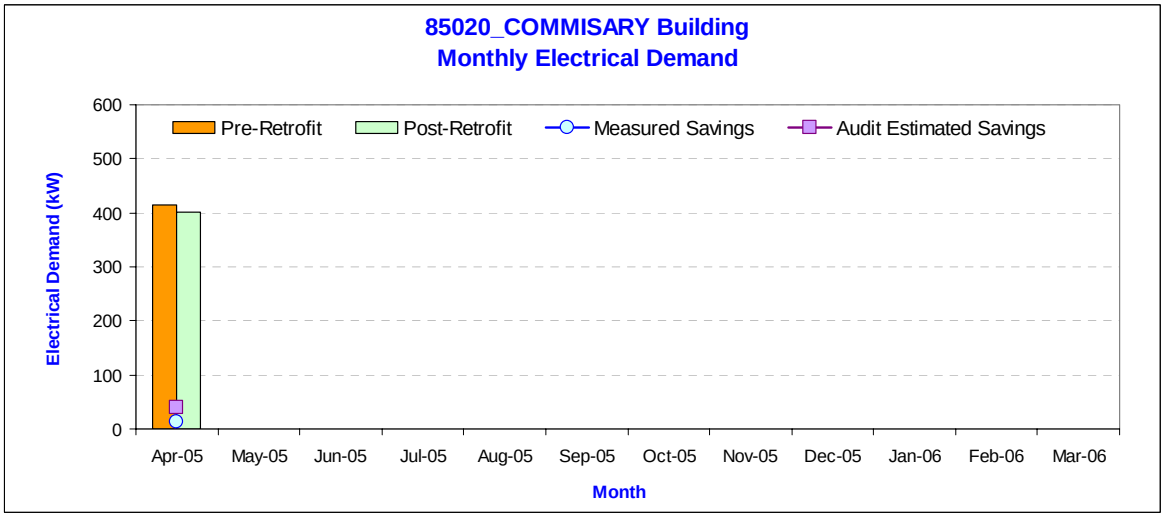

Figure 7.4. 85020 Electrical Demand Savings

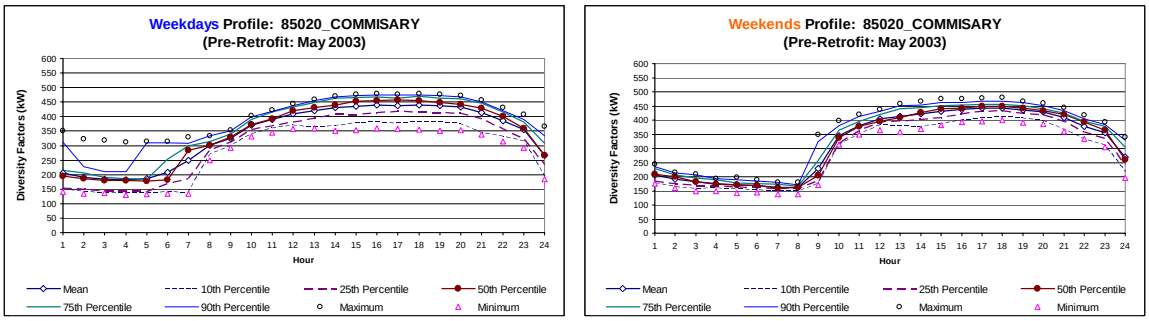

Figure 7.5. 85020 Electrical Demand Model for Pre-retrofit Period

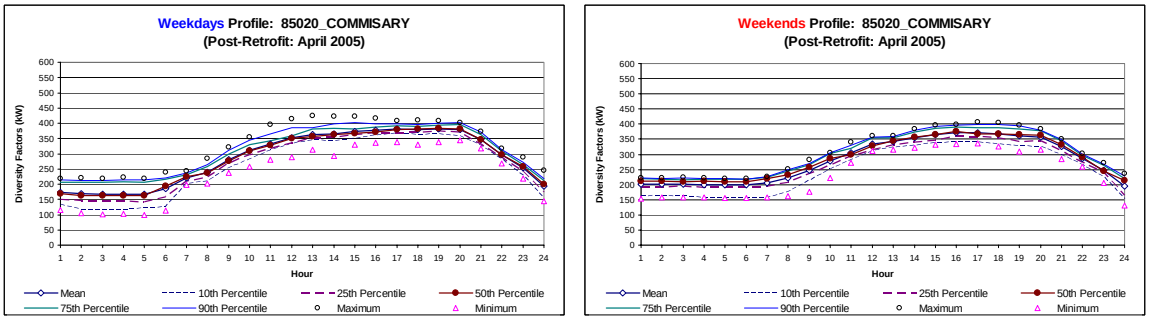

Figure 7.6. 85020 Electrical Demand Model for Post-retrofit Period

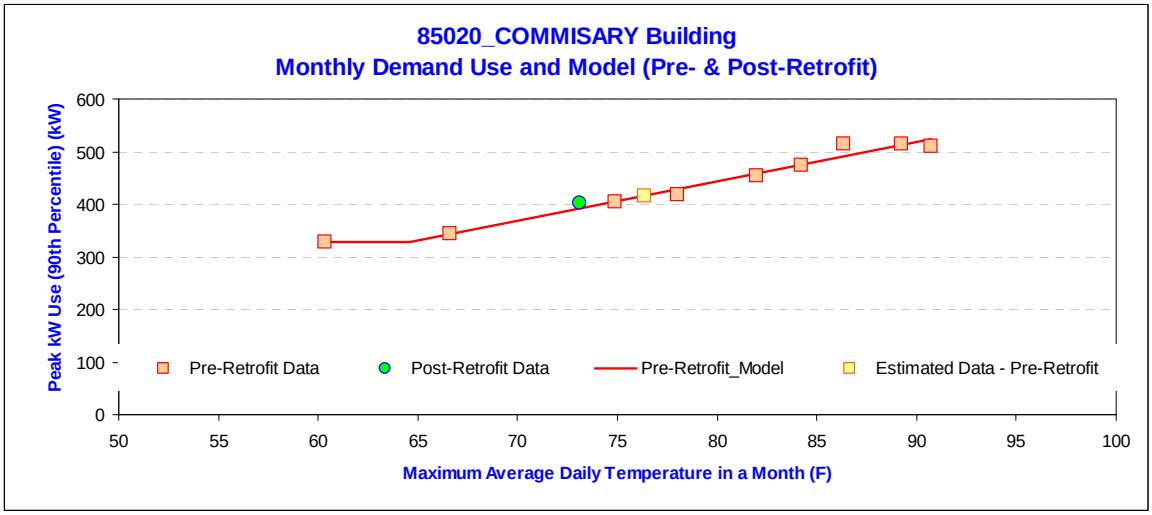

Figure 7.7. 85020 Electrical Demand 3PC Model for Pre-retrofit Period

8. SAVINGS SUMMARY FOR 87017-DINING FACILITY

This section covers the energy and demand savings report for 87017-Dining Facility of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in May 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 41,390 kWh/yr for electricity and 89 kW/yr for electrical demand. As shown in Table 8.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 4,755 kWh for a total of 28 days correspond to 149.8% of the audit estimated savings. This indicates that the retrofits are generally working better than expected at this building. However, additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period although it appears there is a decrease in demand use in the post-retrofit period.

Figure 8.1 shows the time series plot of the daily electricity use of 87017-Dining Facility for the period of January 2001 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 8.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 8.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 8.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 8.5, the data for the period of March 16, 2003 to August 26, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) developed from measured data, are displayed in Figure 8.6 and Figure 8.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 86 kW and 79 kW, respectively.

In Figure 8.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. It appears that demand savings were achieved in June, July and August of 2005. However, due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 8.1. Savings Summary for 87017

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	5	1,045	567	184.3%
Jul-05	10	2,760	1,134	243.4%
Aug-05	13	950	1,474	64.5%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**4,755**	**3,175**	**149.8%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	5	N/A	7.40	N/A
Jul-05	10	N/A	7.40	N/A
Aug-05	13	N/A	7.40	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**N/A**	**22**	**N/A**

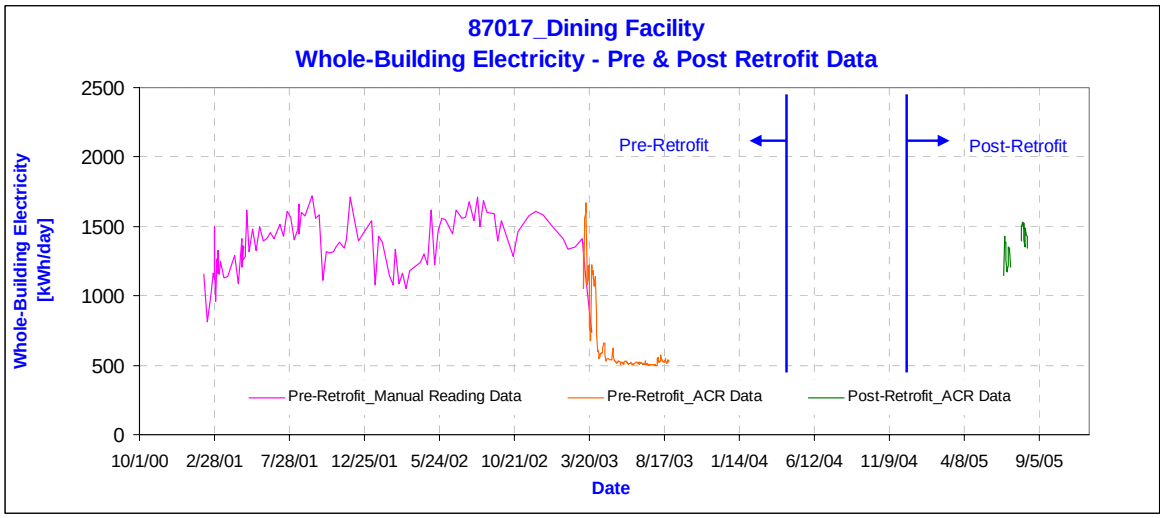

Figure 8.1. 87017 Daily Electricity Use

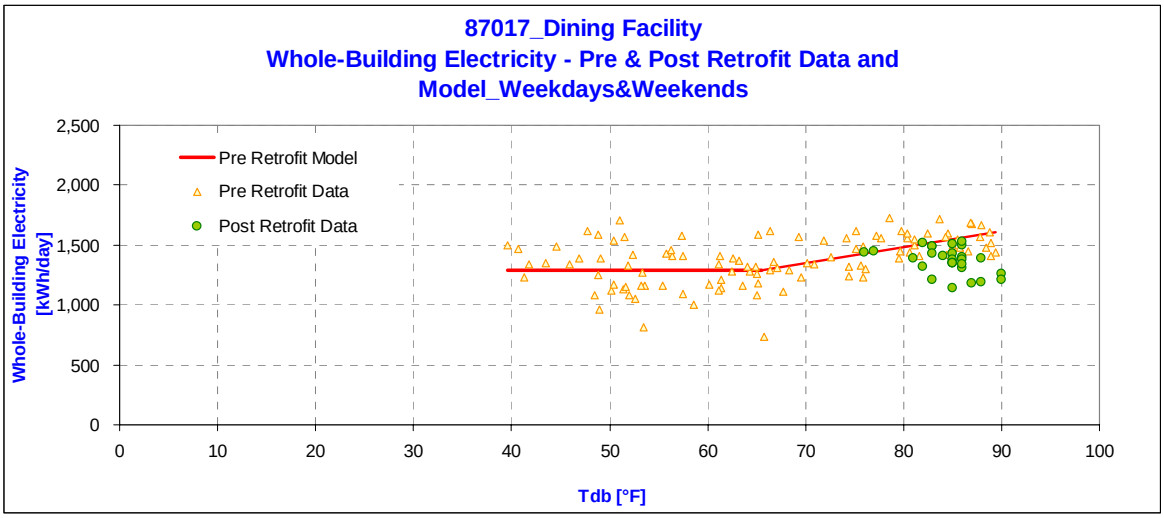

Figure 8.2. 87017 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

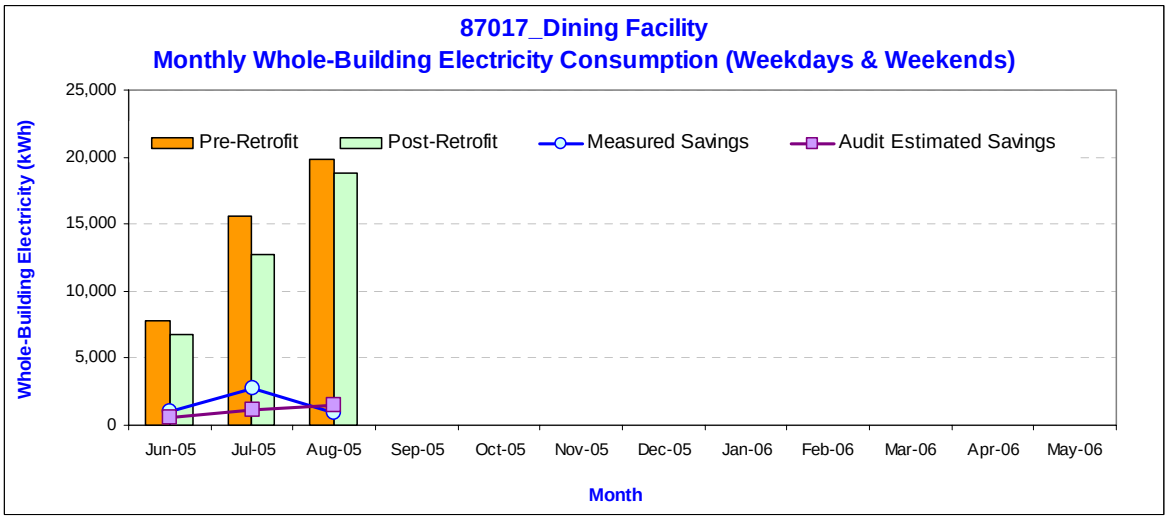

Figure 8.3. 87017 Electricity Savings

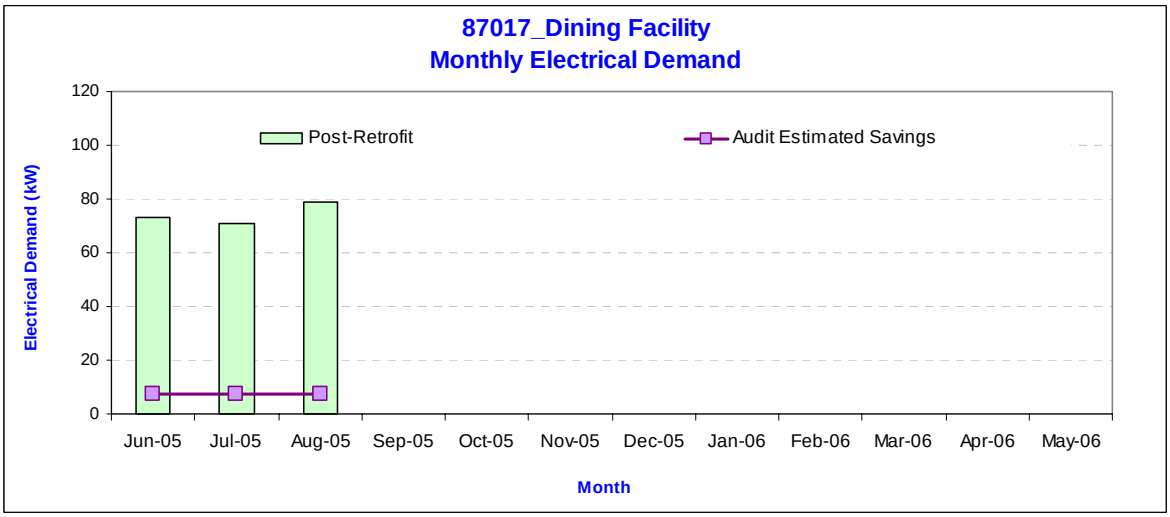

Figure 8.4. 87017 Electrical Demand Savings

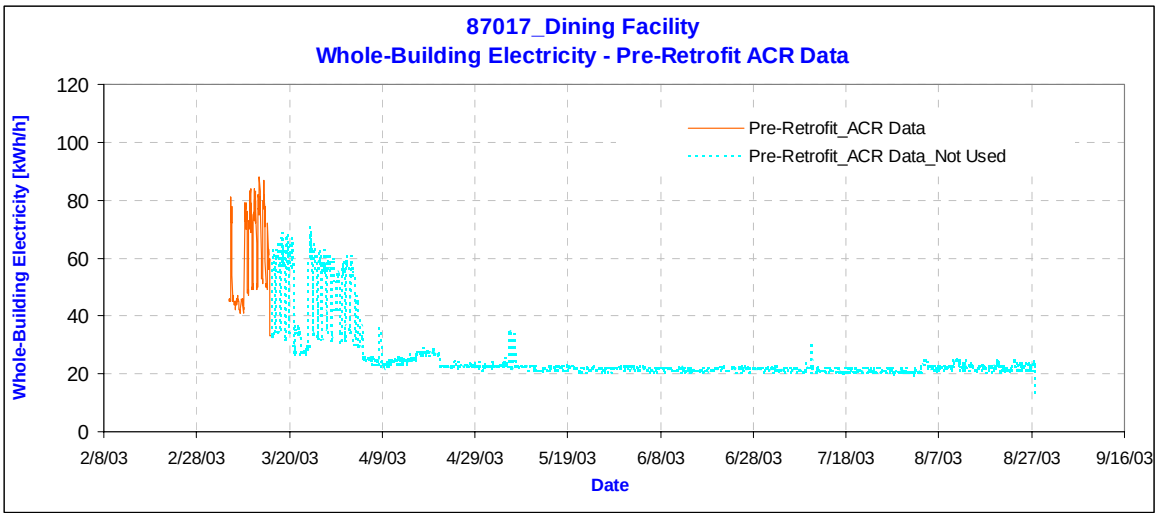

Figure 8.5. 87017 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

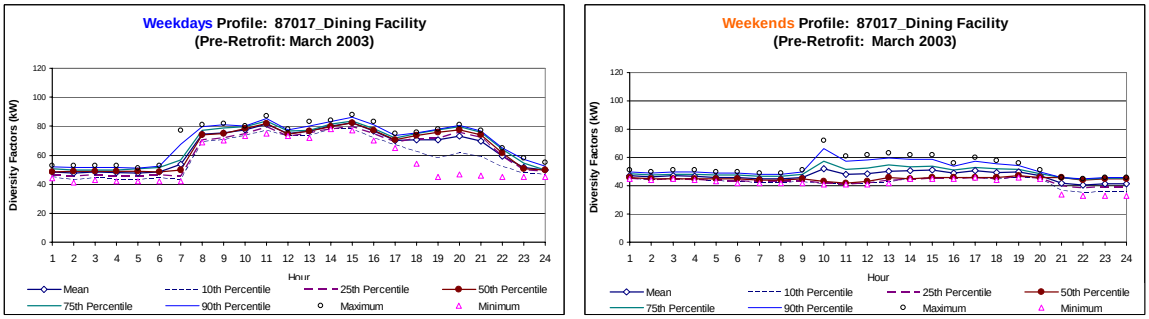

Figure 8.6. 87017 Electrical Demand Model for Pre-retrofit Period

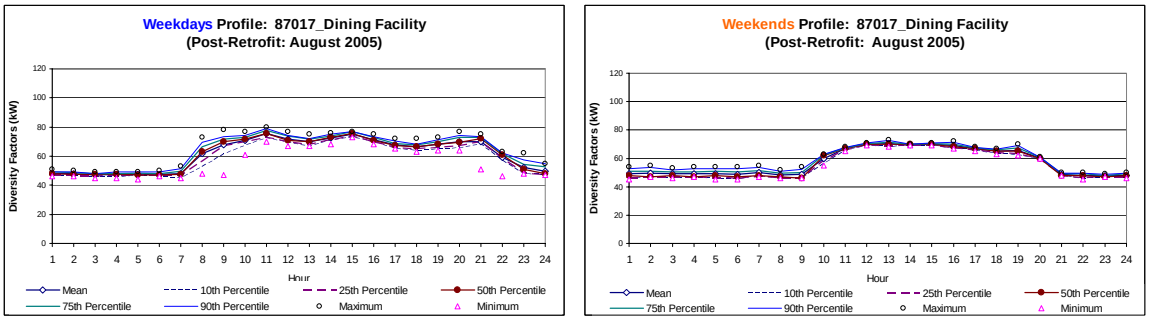

Figure 8.7. 87017 Electrical Demand Model for Post-retrofit Period

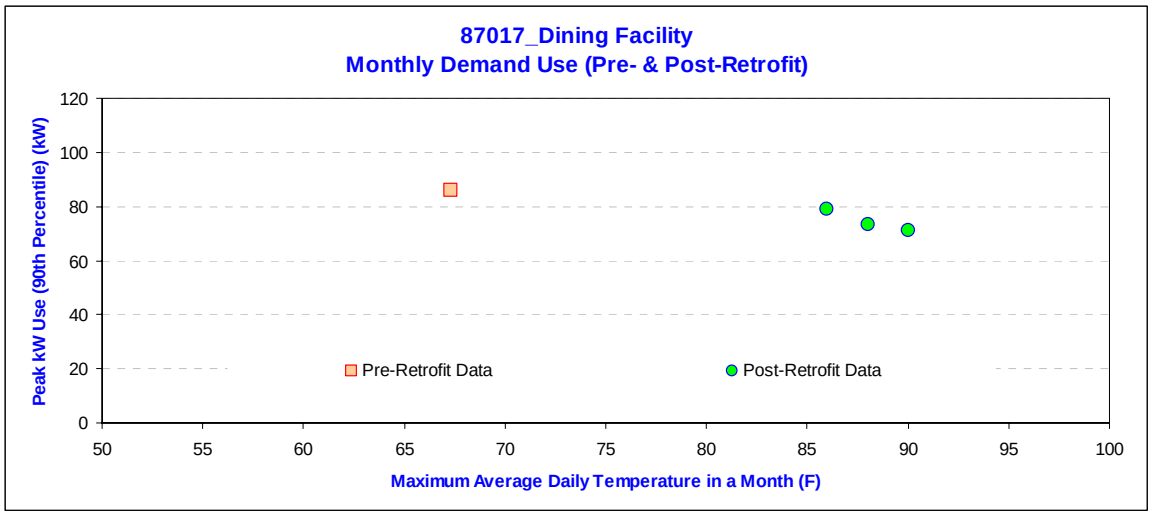

Figure 8.8. 87017 Electrical Demand Use for Pre- and Post-retrofit Periods

9. SAVINGS SUMMARY FOR 87008-BN HQ BUILDING

This section covers the energy and demand savings report for 87008-BN HQ Building of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 18,412 kWh/yr for electricity and 70 kW/yr for electrical demand. As shown in Table 9.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,173 kWh for a total of 28 days correspond to 153.9% of the audit estimated savings. This indicates that the retrofits are generally working better than expected at this building. However, additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period although it appears there is a decrease in demand use in the post-retrofit period.

Figure 9.1 shows the time series plot of the daily electricity use of 87008-BN HQ Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to the lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 9.2. The hourly data for the post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the one-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 9.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 9.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 9.5, the data for the period of March 29, 2003 to August 26, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 9.6 and Figure 9.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 22 kW and 17 kW, respectively.

In Figure 9.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. It appears that demand savings were achieved in June, July and August of 2005. However, due to the missing data in the pre-retrofit period compared against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 9.1. Savings Summary for 87008

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	5	297	252	117.8%
Jul-05	10	1,047	504	207.6%
Aug-05	13	829	656	126.4%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**2,173**	**1,412**	**153.9%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	5	N/A	5.83	N/A
Jul-05	10	N/A	5.83	N/A
Aug-05	13	N/A	5.83	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**N/A**	**18**	**N/A**

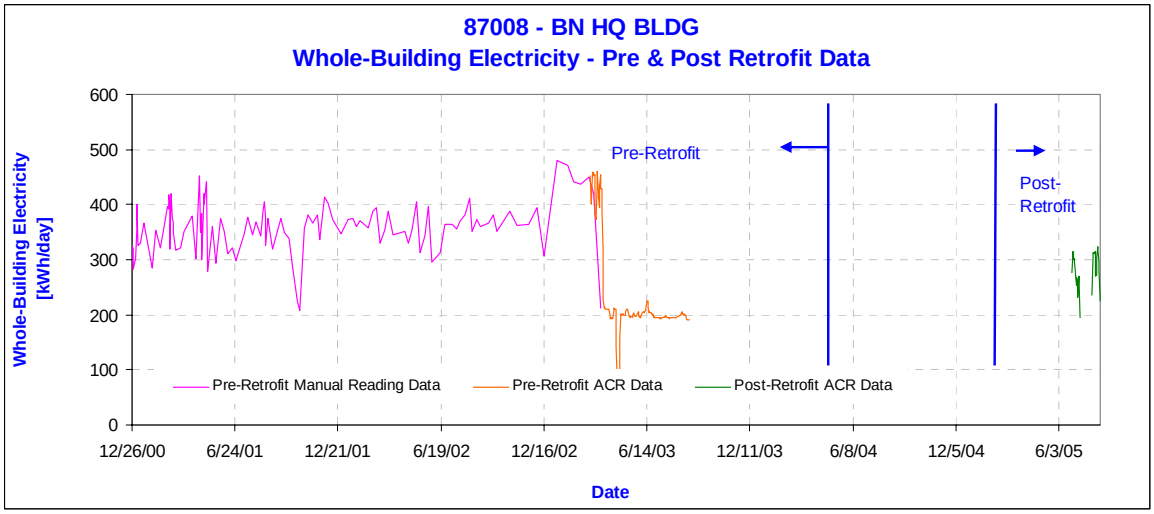

Figure 9.1. 87008 Daily Electricity Use

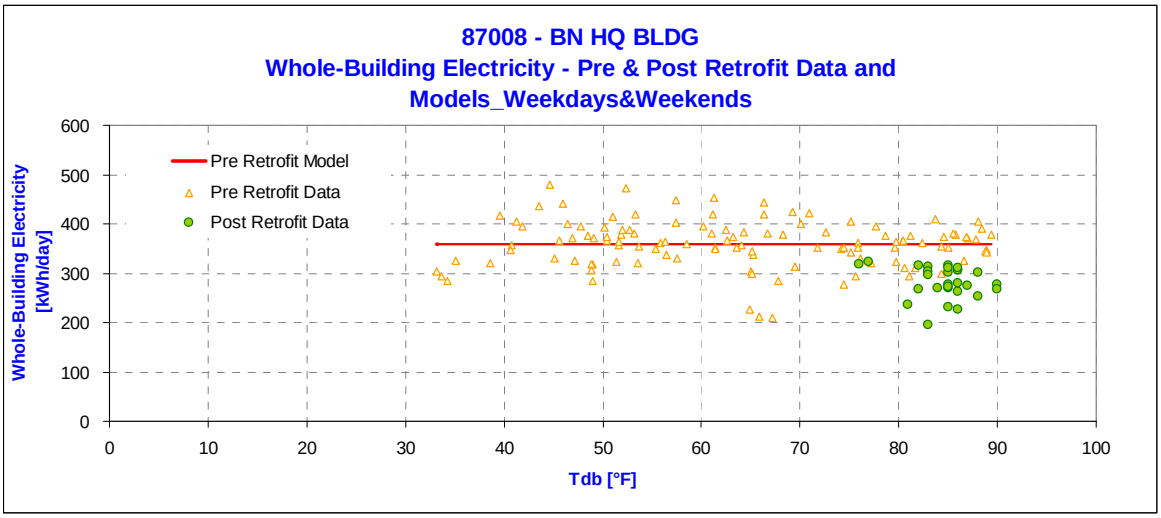

Figure 9.2. 87008 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

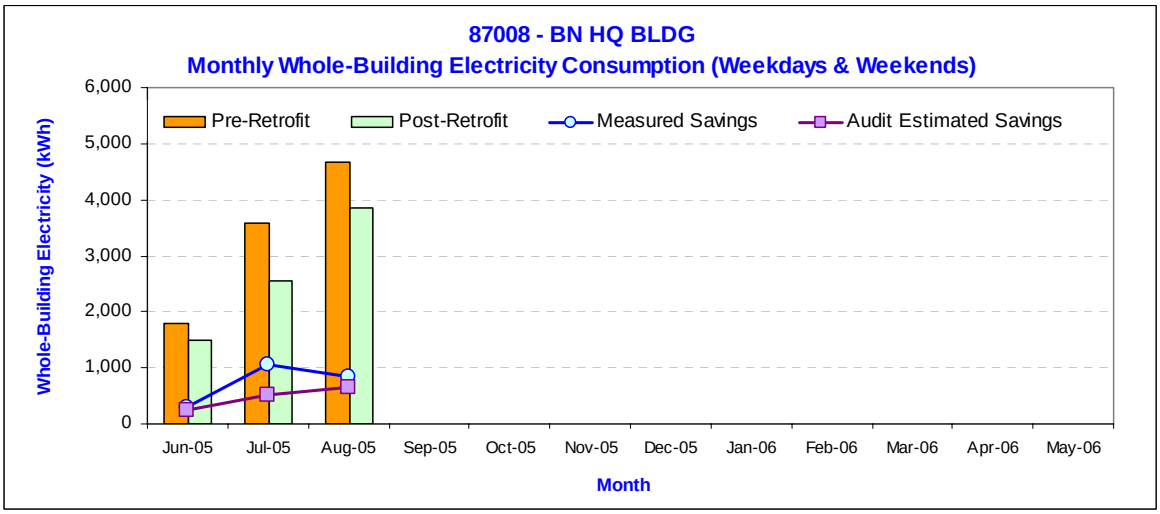

Figure 9.3. 87008 Electricity Savings

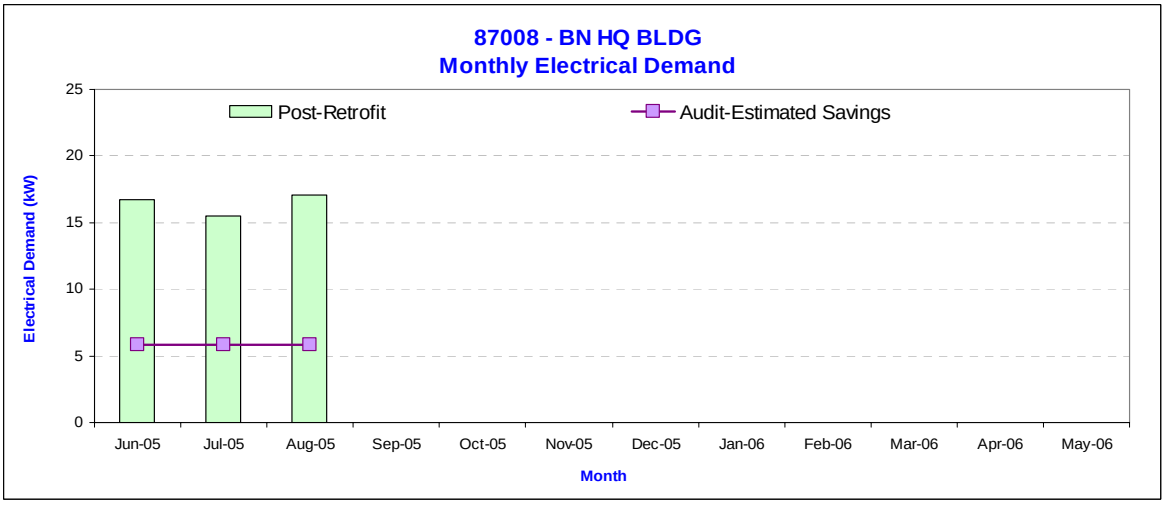

Figure 9.4. 87008 Electrical Demand Savings

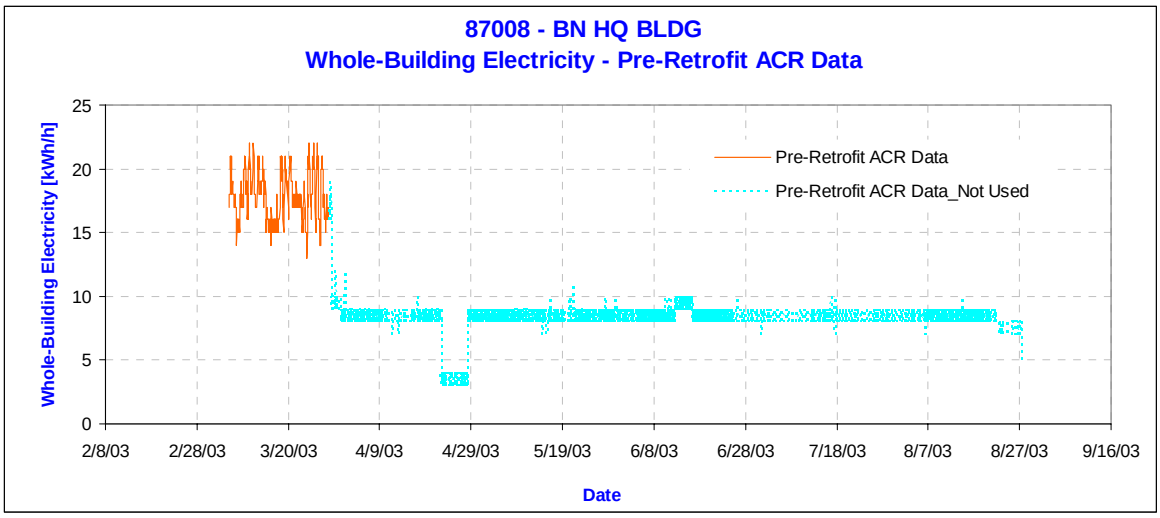

Figure 9.5. 87008 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

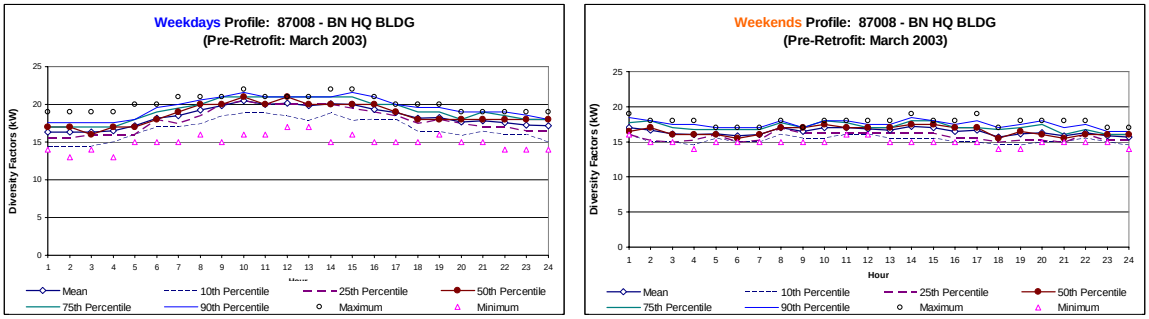

Figure 9.6. 87008 Electrical Demand Model for Pre-retrofit Period

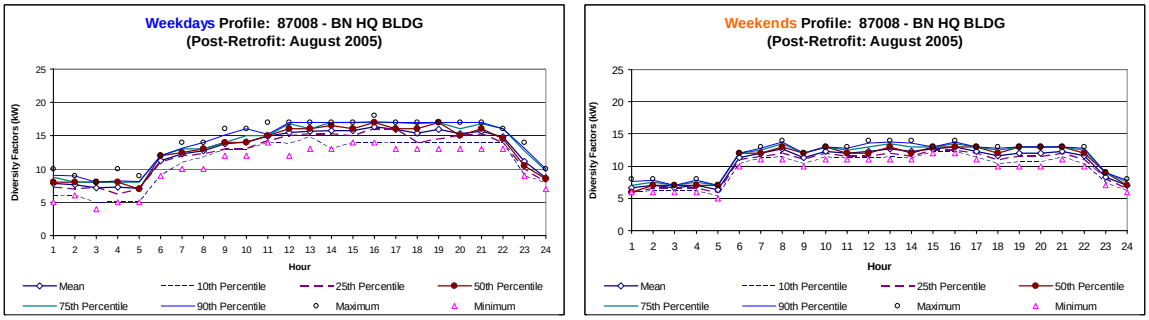

Figure 9.7. 87008 Electrical Demand Model for Post-retrofit Period

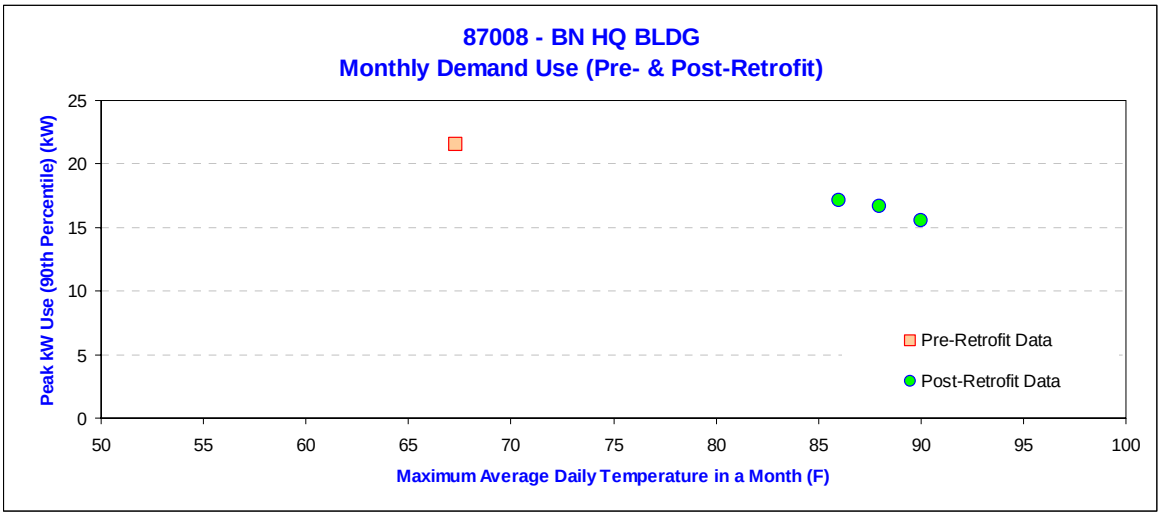

Figure 9.8. 87008 Electrical Demand Use for Pre- and Post-retrofit Periods

10. SAVINGS SUMMARY FOR 87003-BN HQ BUILDING & OR

This section covers the energy and demand savings report for 87003-BN HQ Building & OR of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 51,320 kWh/yr for electricity and 146 kW/yr for electrical demand. As shown in Table 10.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,046 kWh for a total of 14 days correspond to 104.0% of the audit estimated savings. This indicates that the retrofits are generally working as expected at this building. However, additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period although it appears there is a decrease in demand use in the post-retrofit period.

Figure 10.1 shows the time series plot of the daily electricity use of 87003-BN HQ Building & OR for the period of December 2000 through March 2003 (manual reading data), January 2003 through August 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 10.2. The data for the period of January 22, 2002 through February 19, 2002 were excluded in the analysis because they appear to be unreasonably low and no information was provided to explain the unusually low usage in this period. The hourly data for the post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the one-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 10.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 10.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 10.5, the data for the period April 1, 2003 to August 10, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 10.6 and Figure 10.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 29 kW and 23 kW, respectively.

In Figure 10.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. It appears that demand savings were achieved in August of 2005. However, due to the missing data in the pre-retrofit period compared against the same months of the post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 10.1. Savings Summary for 87003

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	1	188	141	133.5%
Aug-05	13	1,859	1,828	101.7%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**14**	**2,046**	**1,968**	**104.0%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	1	N/A	12.17	N/A
Aug-05	13	N/A	12.17	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**14**	**N/A**	**24**	**N/A**

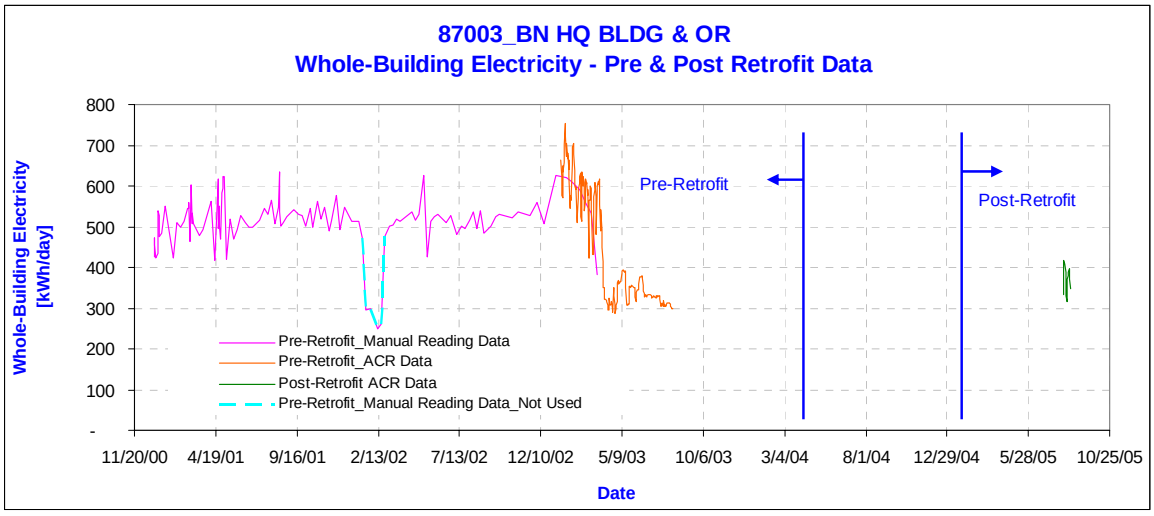

Figure 10.1. 87003 Daily Electricity Use

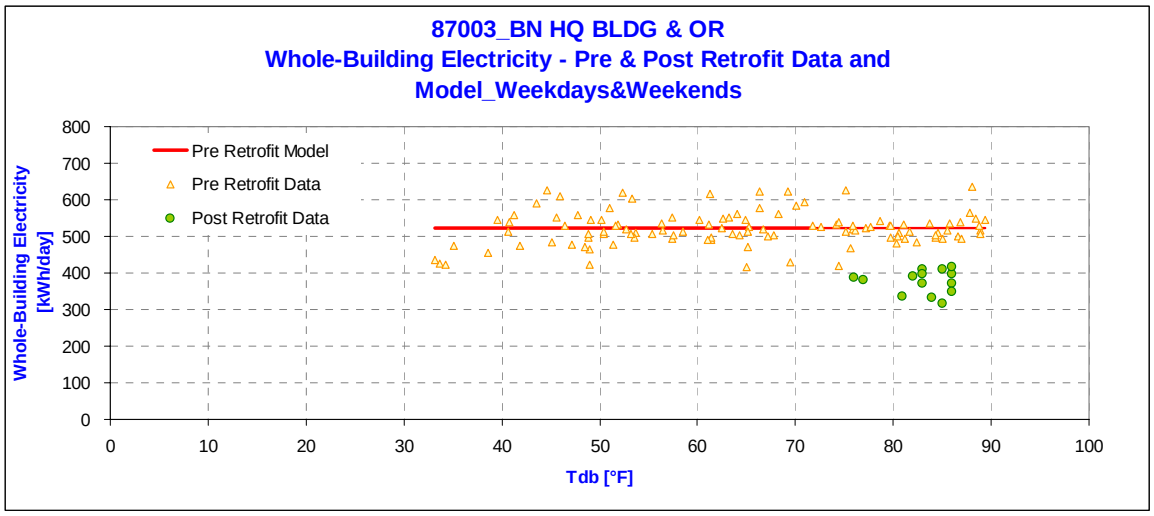

Figure 10.2. 87003 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

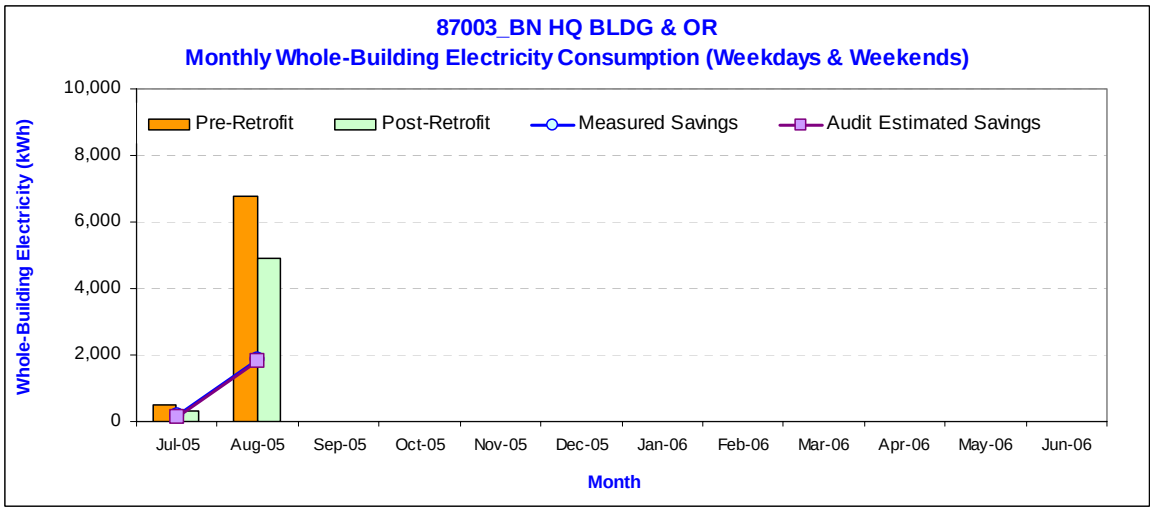

Figure 10.3. 87003 Electricity Savings

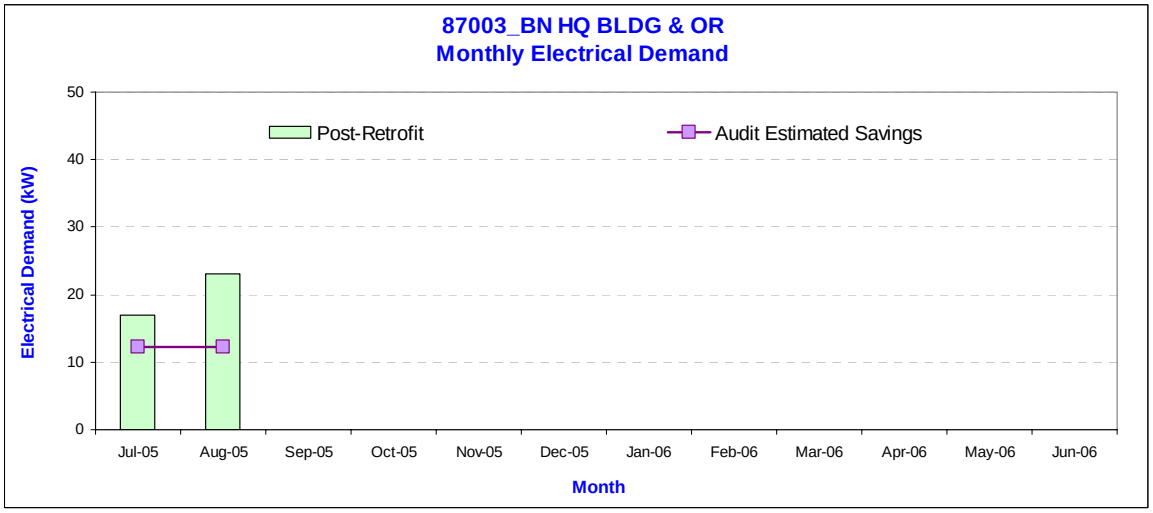

Figure 10.4. 87003 Electrical Demand Savings

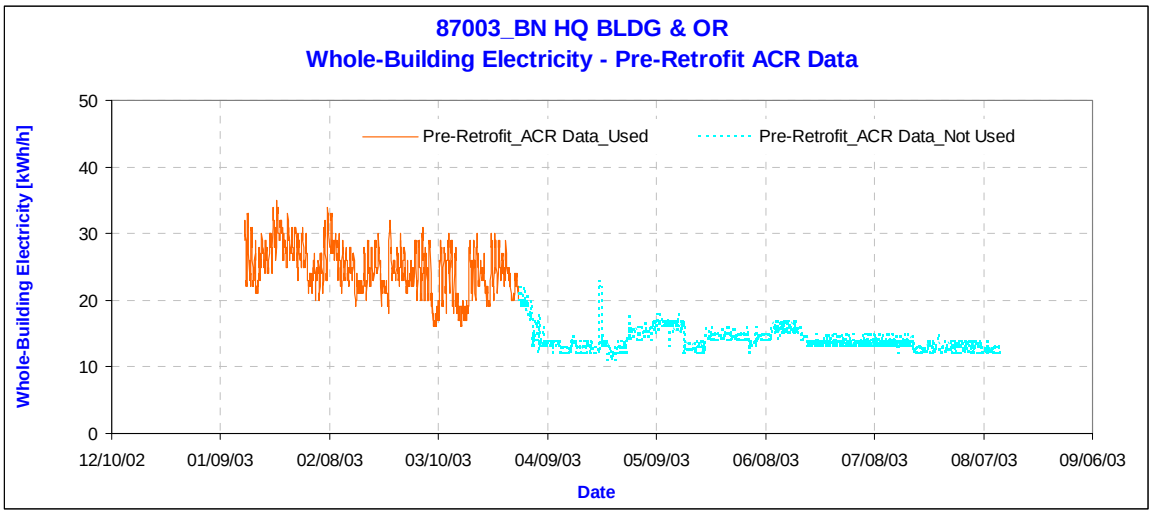

Figure 10.5. 87003 Hourly ACR Data for the Pre-Retrofit Period (January 2003 to August 2003)

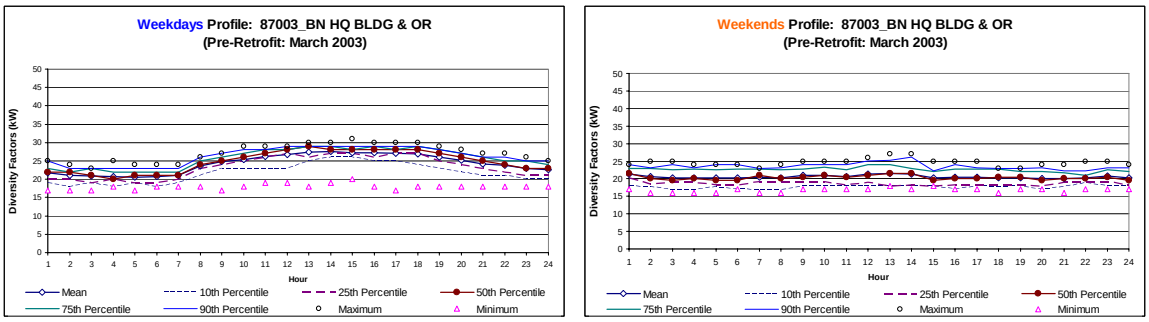

Figure 10.6. 87003 Electrical Demand Model for Pre-retrofit Period

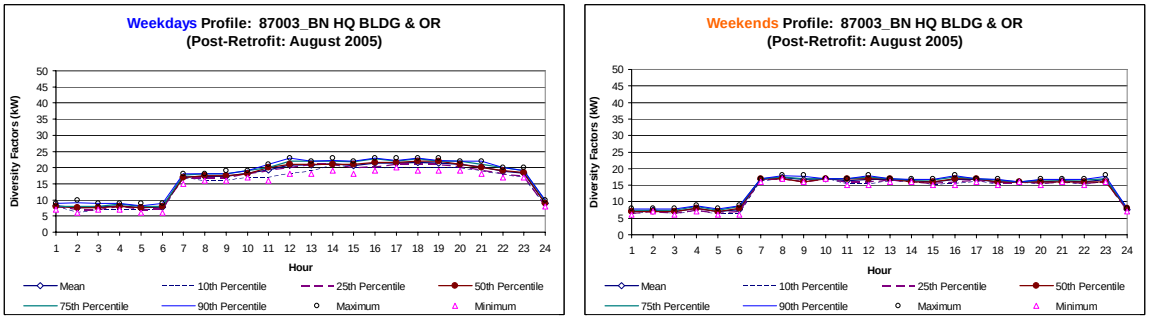

Figure 10.7. 87003 Electrical Demand Model for Post-retrofit Period

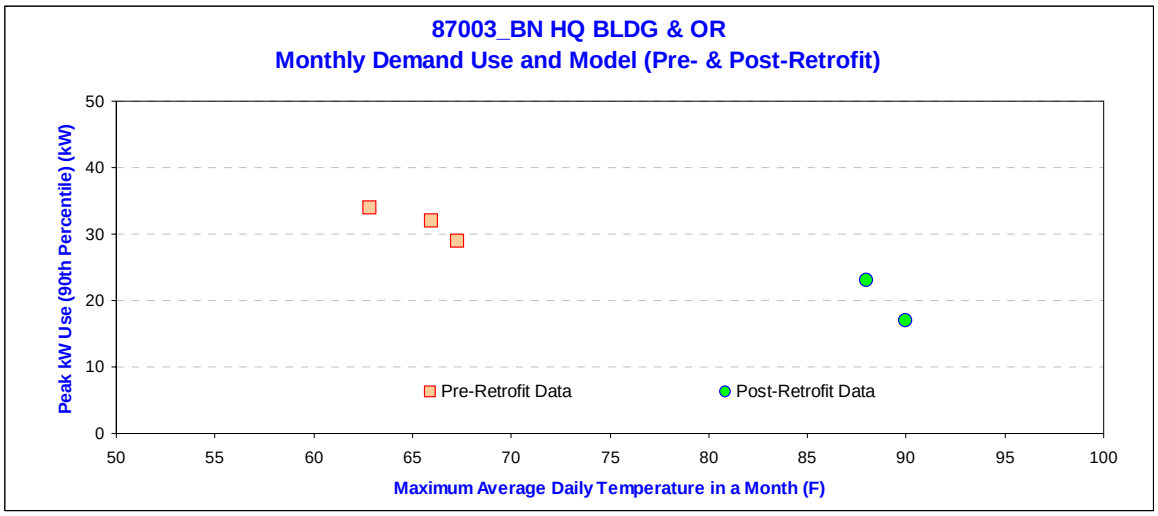

Figure 10.8. 87003 Electrical Demand Use for Pre- and Post-retrofit Periods

11. SAVINGS SUMMARY FOR 87009-BN HQ BUILDING

This section covers the energy and demand savings report for 87009-BN HQ Building of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 49,190 kWh/yr for electricity and 162 kW/yr for electrical demand. As shown in Table 11.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,760 kWh for a total of 28 days correspond to 73.1% of the audit estimated savings. The total of measured monthly demand savings of 7.40 kW is low when compared to the audit estimated demand savings. This may be due to the decrease of the demand use in the pre-retrofit period when the troops deployed.

Figure 11.1 shows the time series plot of the daily electricity use of 87009- BN HQ Building for the period of December 2000 through March 2003 (manual reading data), January 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 11.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the one-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 11.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 11.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of August 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 11.5 and Figure 11.6, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for August 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 32kW and 29 kW, respectively. Therefore, the savings for August 2005 is 3 kW.

However, as shown in Figure 11.7, the demand use decreased for the period April 1, 2003 to August 10, 2003 due to the deployment of the troops. In Figure 11.8, the maximum and minimum demand use vary significantly from the 50^{th} percentiles during the entire pre-retrofit period, which indicates a significant demand use change in this period. The same trend is also shown in Figure 11.9, where the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. This may explain why the calculated demand savings are not meeting expectations.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 11.1. Savings Summary for 87009

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	5	396	674	58.7%
Jul-05	10	1,285	1,348	95.3%
Aug-05	13	1,080	1,752	61.6%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**2,760**	**3,773**	**73.1%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	5	2.00	13.50	N/A (14.8%)
Jul-05	10	2.50	13.50	N/A (18.5%)
Aug-05	13	2.90	13.50	N/A (21.5%)
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**7.40**	**41**	**N/A (18.3%)**

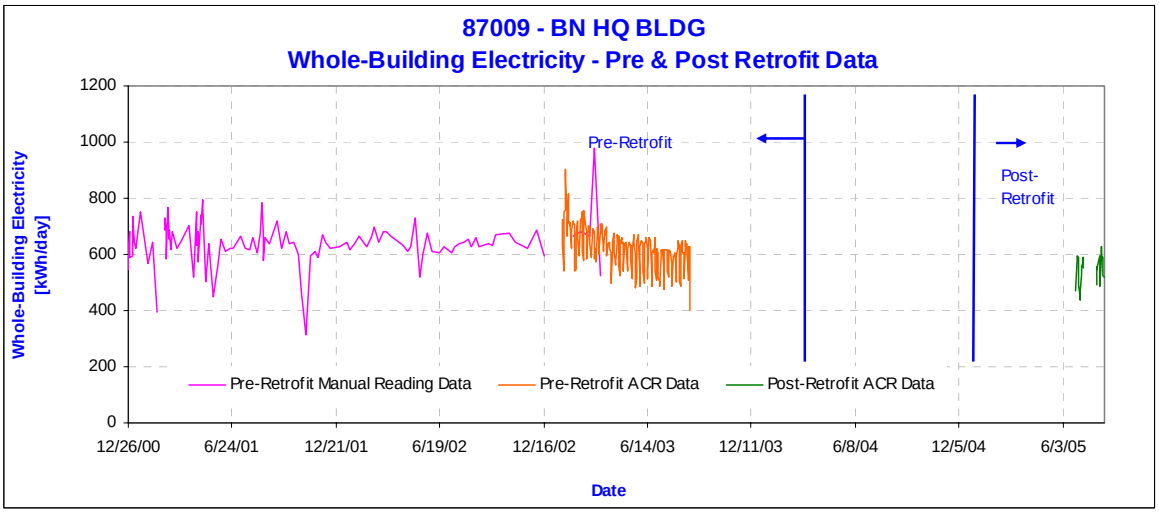

Figure 11.1. 87009 Daily Electricity Use

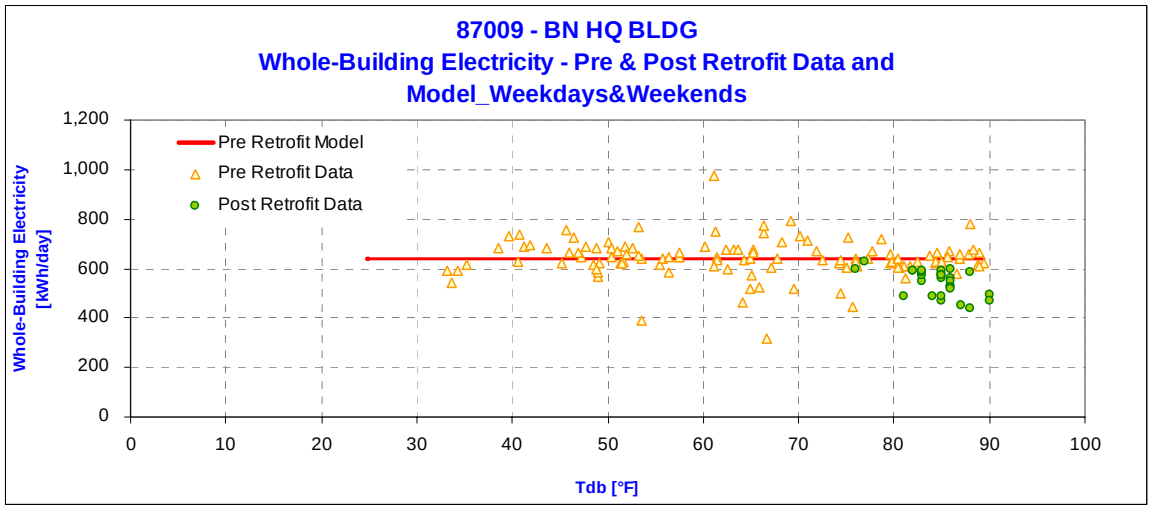

Figure 11.2. 87009 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

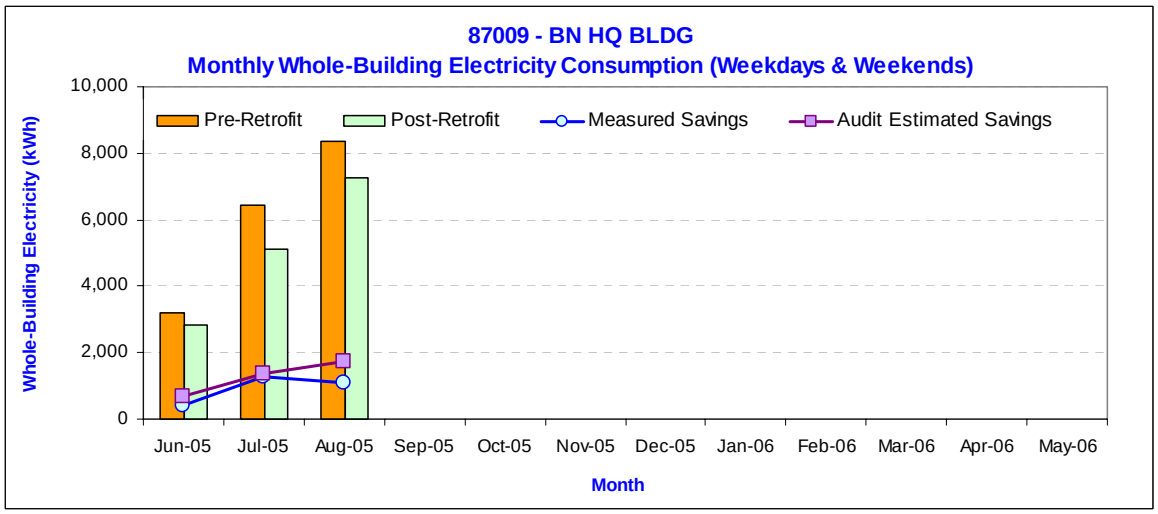

Figure 11.3. 87009 Electricity Savings

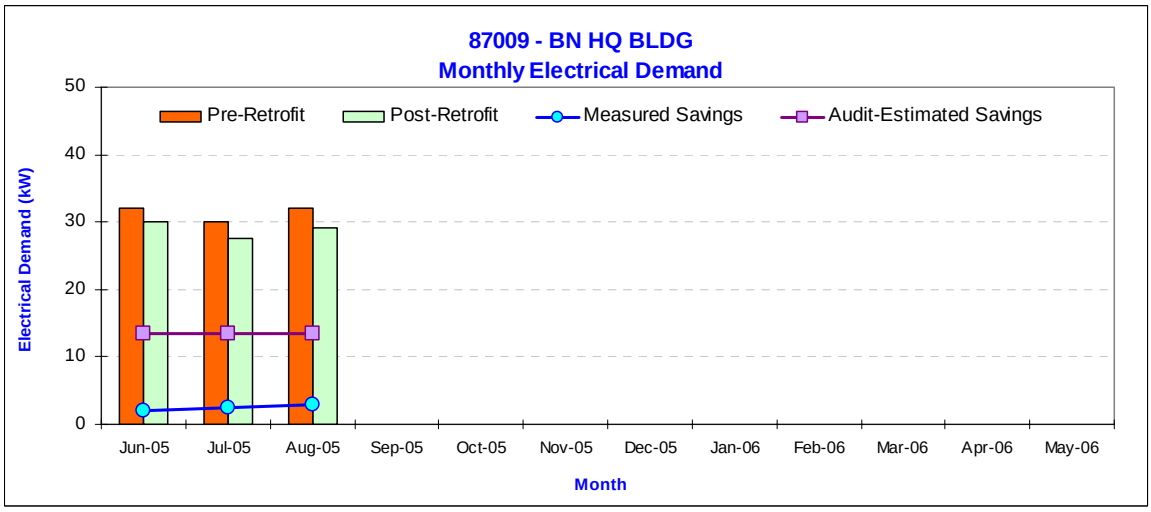

Figure 11.4. 87009 Electrical Demand Savings

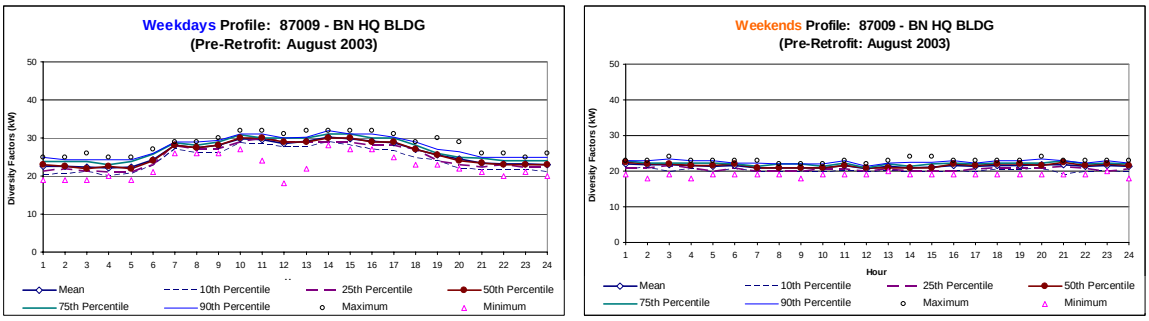

Figure 11.5. 87009 Electrical Demand Model for Pre-retrofit Period

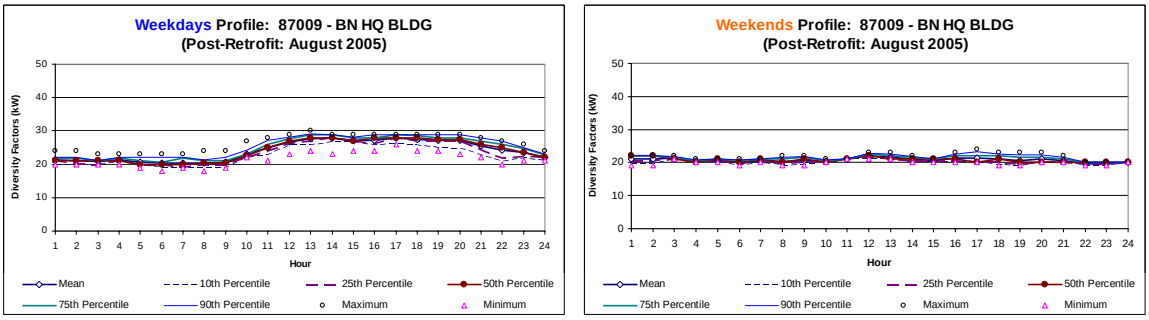

Figure 11.6. 87009 Electrical Demand Model for Post-retrofit Period

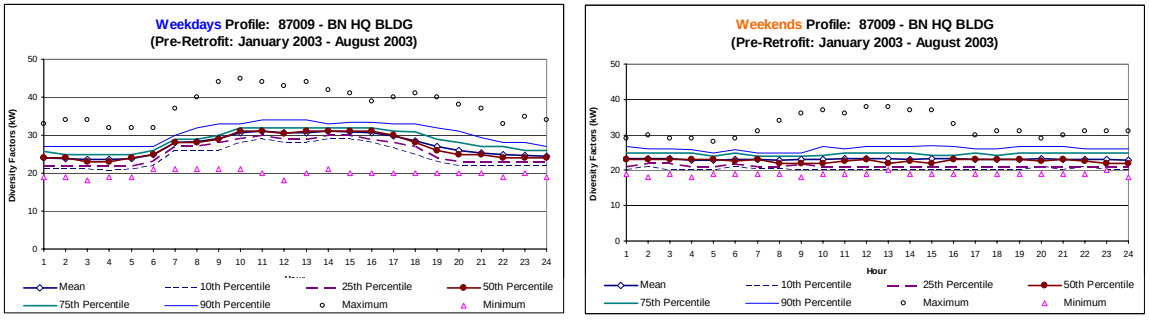

Figure 11.7. 87009 Electrical Demand Model for the Entire Pre-retrofit Period

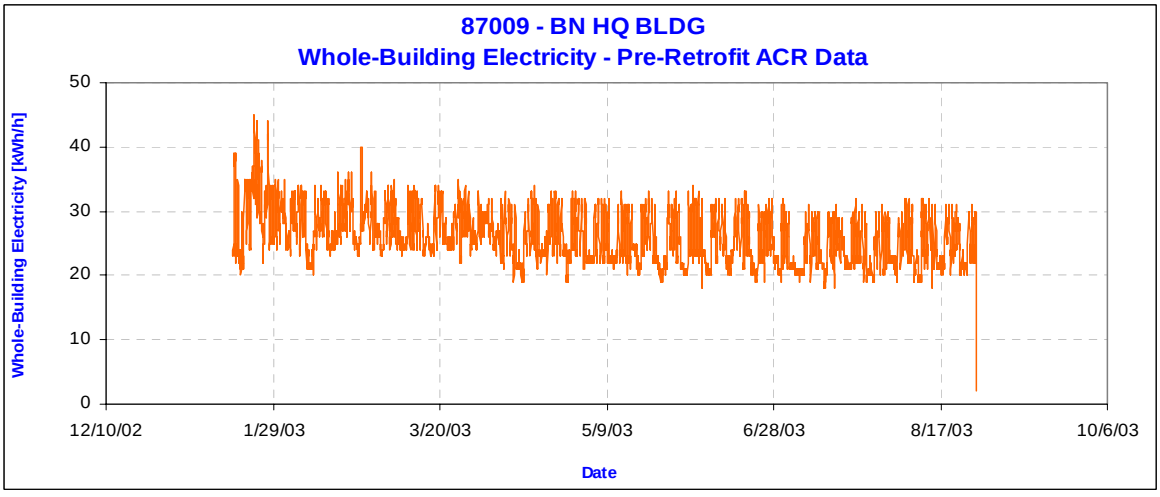

Figure 11.8. 87009 Hourly ACR Data for the Pre-Retrofit Period (January 2003 to August 2003)

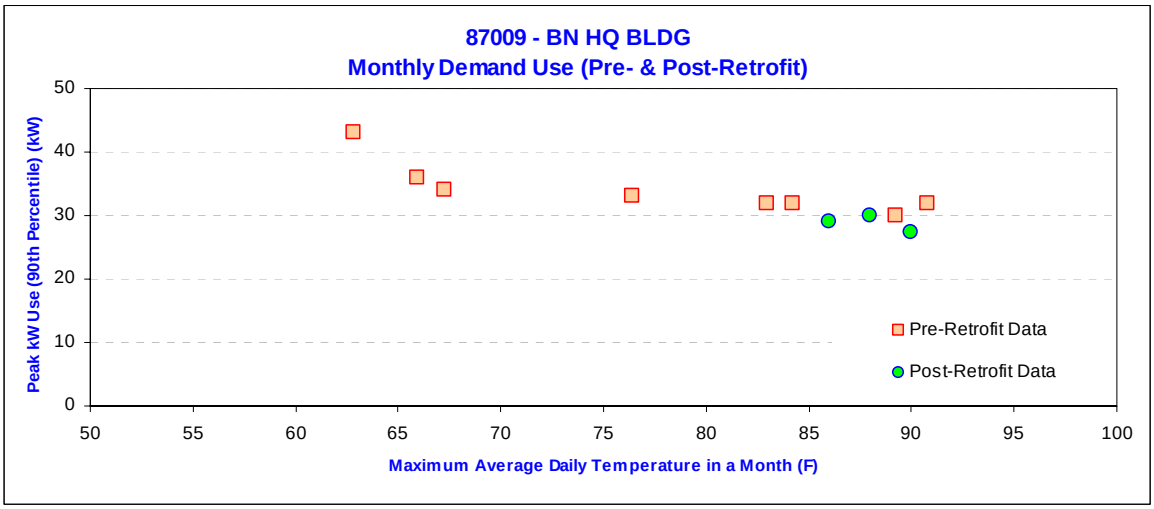

Figure 11.9. 87009 Electrical Demand Use for Pre- and Post-retrofit Periods

12. SAVINGS SUMMARY FOR 87006-HEALTH CLINIC

This section covers the energy and demand savings report for 87006-Health Clinic of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 11,047 kWh/yr for electricity and 44 kW/yr for electrical demand. As shown in Table 12.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 740 kWh for a total of 28 days correspond to 87.4% of the audit estimated savings. This indicates that the retrofits are generally working as expected at this building. However, the total of the monthly demand savings of -2 kW corresponds to an increase in electrical demand for the building. The negative demand savings observed may be due to the deployment of the troops and the operational change in the building in the pre-retrofit period.

Figure 12.1 shows the time series plot of the daily electricity use of 87006-Health Clinic for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The energy use of this building look erratic from the weekly meter reading data and the erratic characteristics continue with the ACR data for the pre-retrofit period. The manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 12.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the one-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 12.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 12.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of August 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 12.5 and Figure 12.6, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for August 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 6 kW and 7 kW, respectively. Therefore, the savings for August 2005 is -1 kW.

However, as shown in Figure 12.7, the demand use decreased for the period April 1, 2003 to August 10, 2003 due to the deployment of the troops. The same trend is shown in Figure 12.8, where the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. This may explain why the calculated demand savings are not meeting expectations.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 12.1. Savings Summary for 87006

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	5	52	151	34.2%
Jul-05	10	341	303	112.5%
Aug-05	13	348	393	88.5%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**740**	**847**	**87.4%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	5	-1.70	3.69	N/A (-46.1%)
Jul-05	10	-0.08	3.69	N/A (-2.1%)
Aug-05	13	-0.14	3.69	N/A (-3.9%)
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**-2**	**11**	**N/A (-17.3%)**

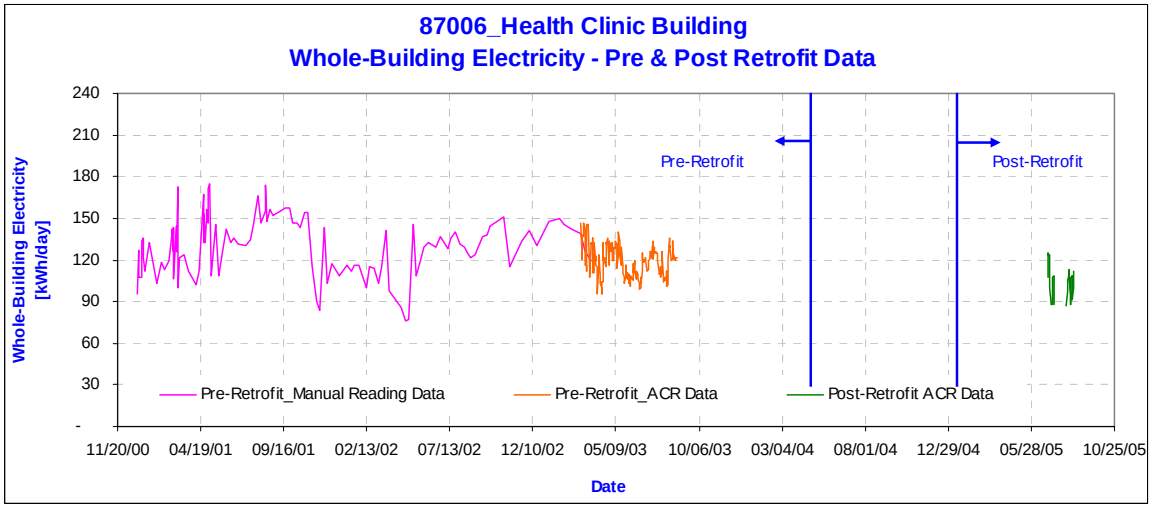

Figure 12.1. 87006 Daily Electricity Use

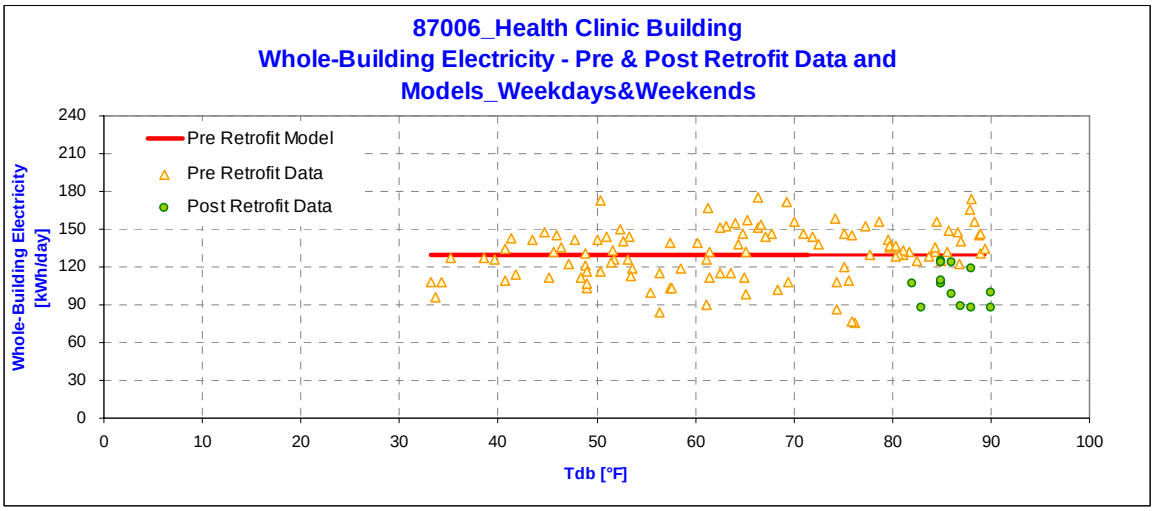

Figure 12.2. 87006 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

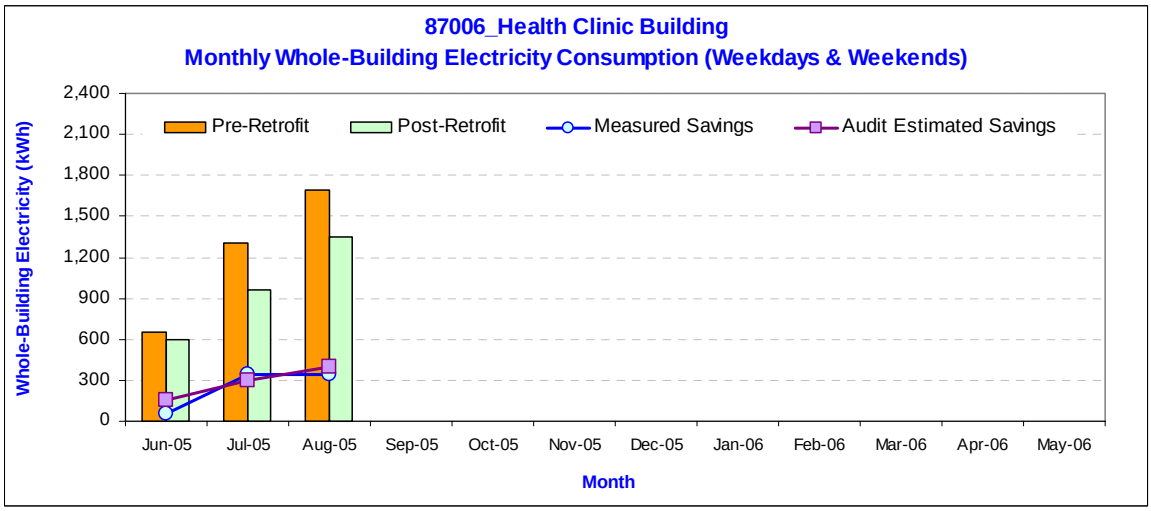

Figure 12.3. 87006 Electricity Savings

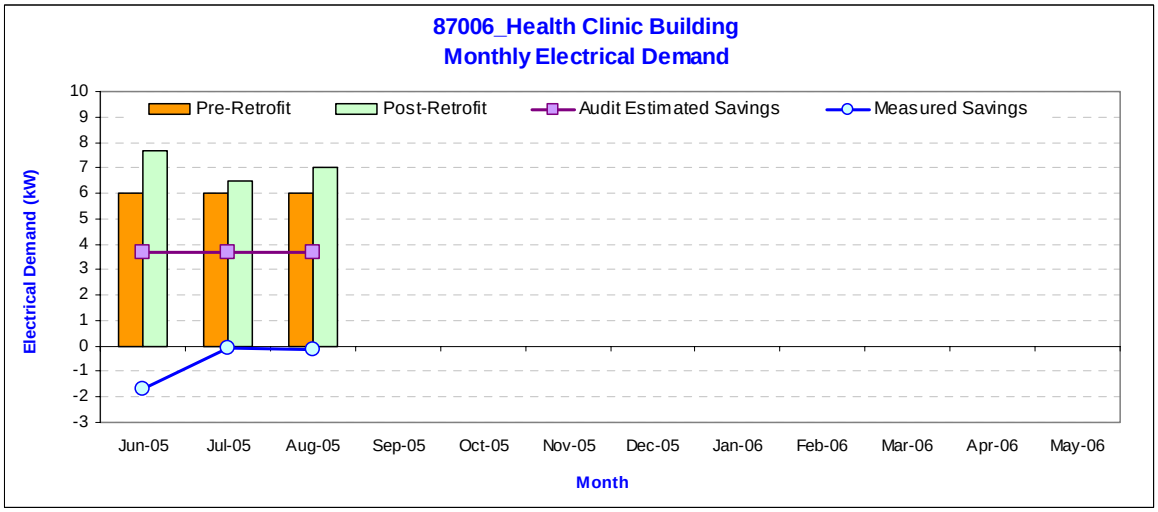

Figure 12.4. 87006 Electrical Demand Savings

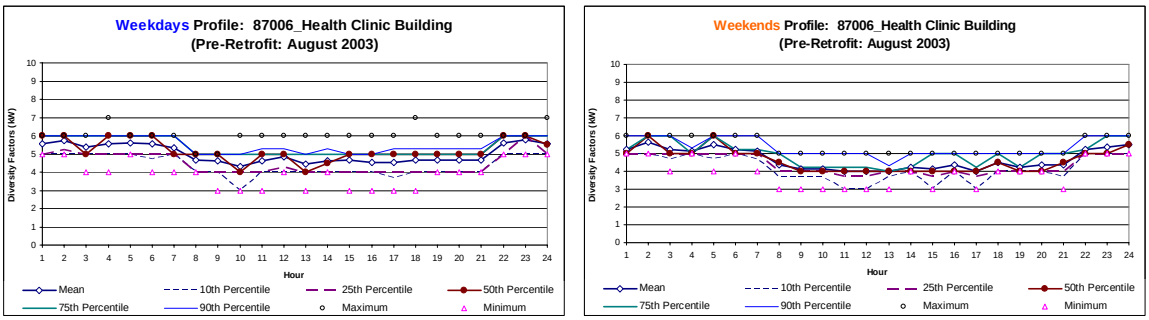

Figure 12.5. 87006 Electrical Demand Model for Pre-retrofit Period

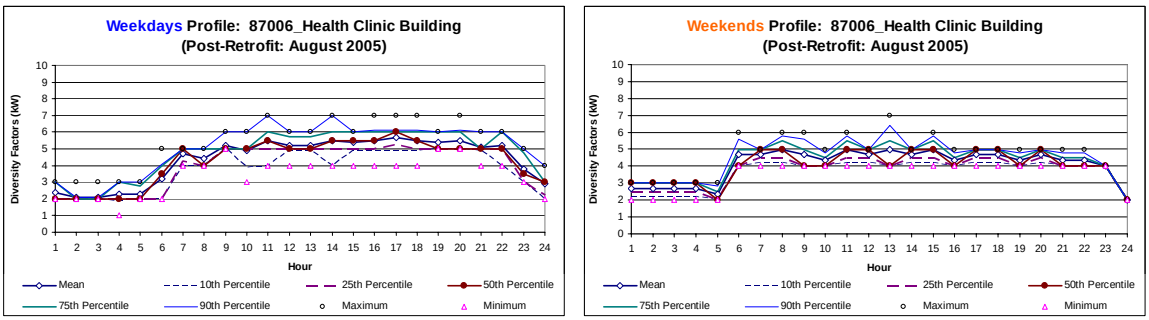

Figure 12.6. 87006 Electrical Demand Model for Post-retrofit Period

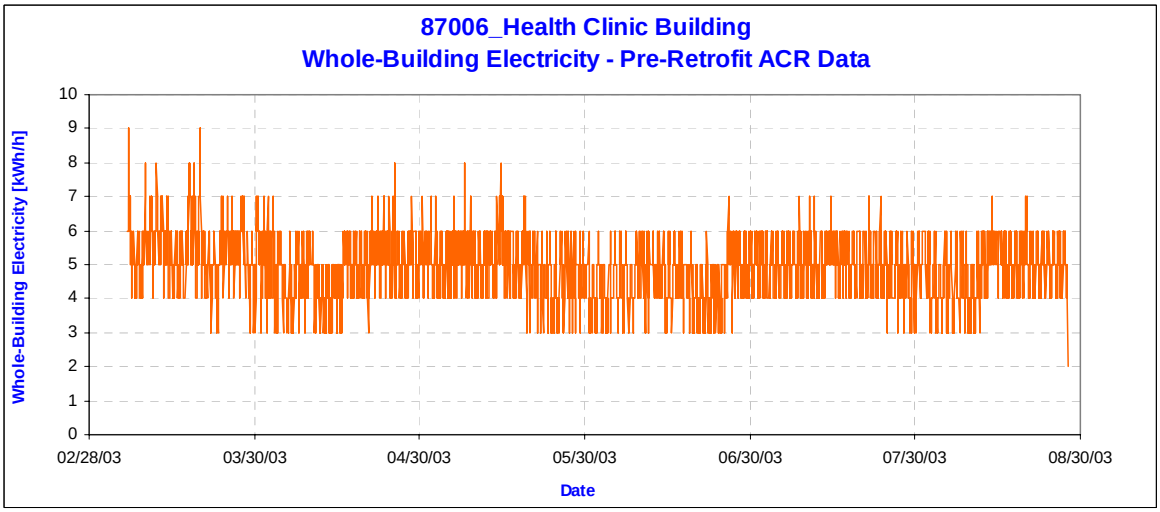

Figure 12.7. 87006 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

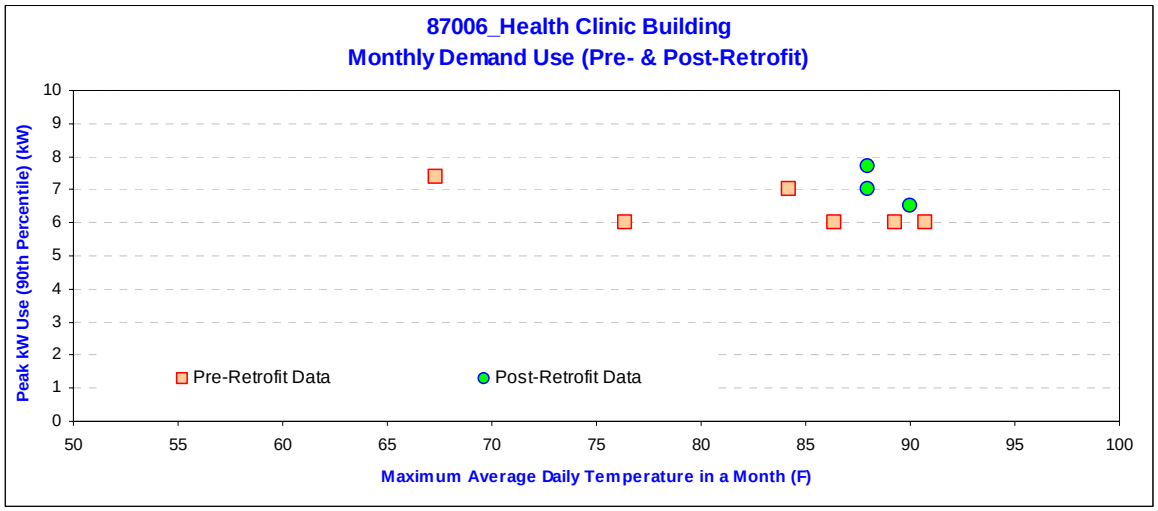

Figure 12.8. 87006 Electrical Demand Use for Pre- and Post-retrofit Periods

13. SAVINGS SUMMARY FOR 87016-CO HQ BUILDING

This section covers the energy and demand savings report for 87016-CO HQ Building of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 50,197 kWh/yr for electricity and 157 kW/yr for electrical demand. As shown in Table 13.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 3,235 kWh for a total of 14 days correspond to 168.0% of the audit estimated savings. This indicates that the retrofits are generally working better than expected at this building. However, additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 13.1 shows the time series plot of the daily electricity use of 87016-CO HQ Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to the lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 13.2. The hourly data for the post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 13.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 13.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 13.5, the data for the period April 1, 2003 to August 26, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 13.6 and Figure 13.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 23.4 kW and 23.1 kW, respectively.

In Figure 13.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. Due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 13.1. Savings Summary for 87016

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	1	288	138	209.6%
Aug-05	13	2,946	1,788	164.8%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**14**	**3,235**	**1,925**	**168.0%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	1	N/A	13.12	N/A
Aug-05	13	N/A	13.12	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**14**	**N/A**	**26**	**N/A**

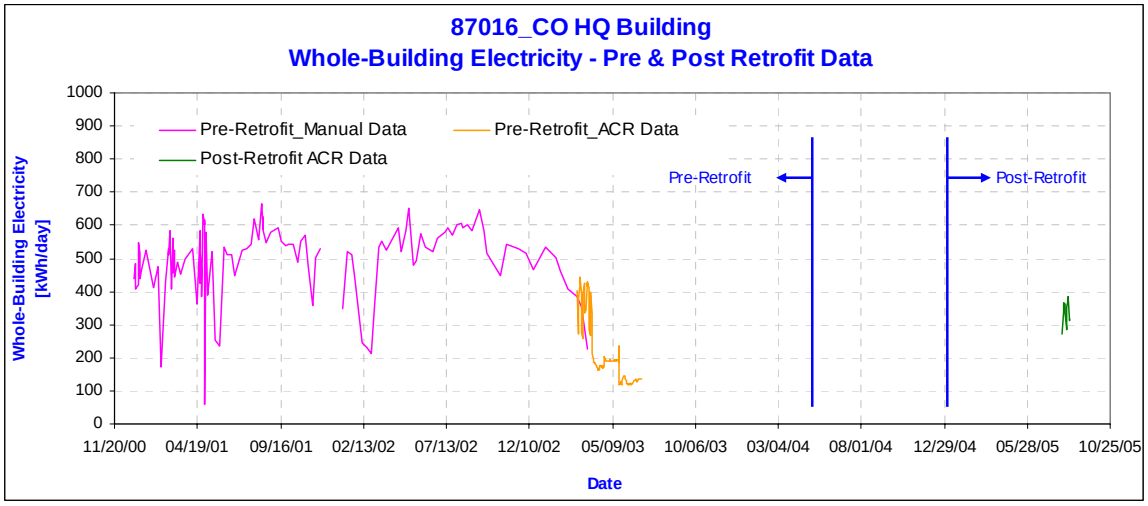

Figure 13.1. 87016 Daily Electricity Use

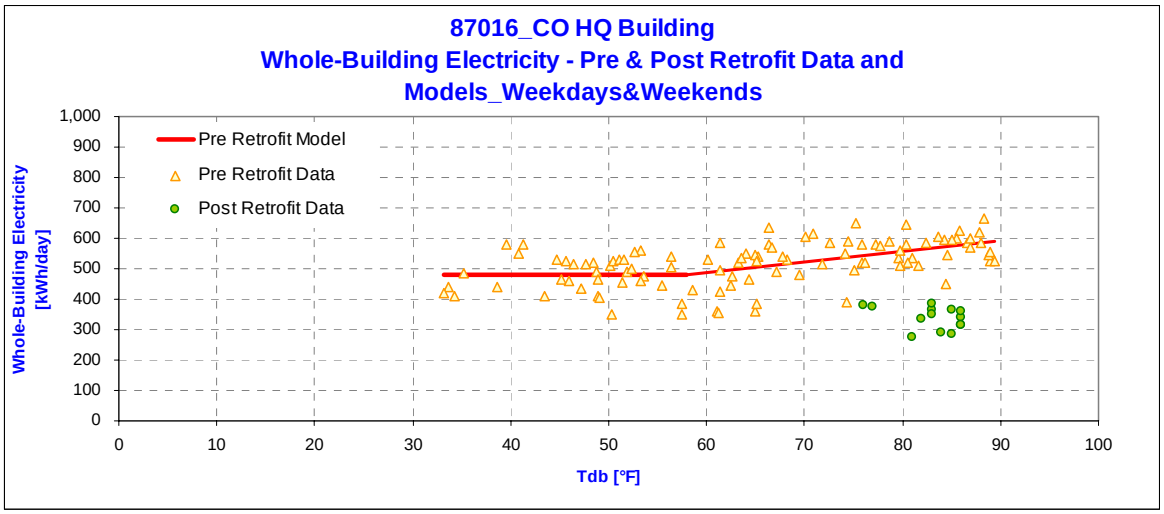

Figure 13.2. 87016 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

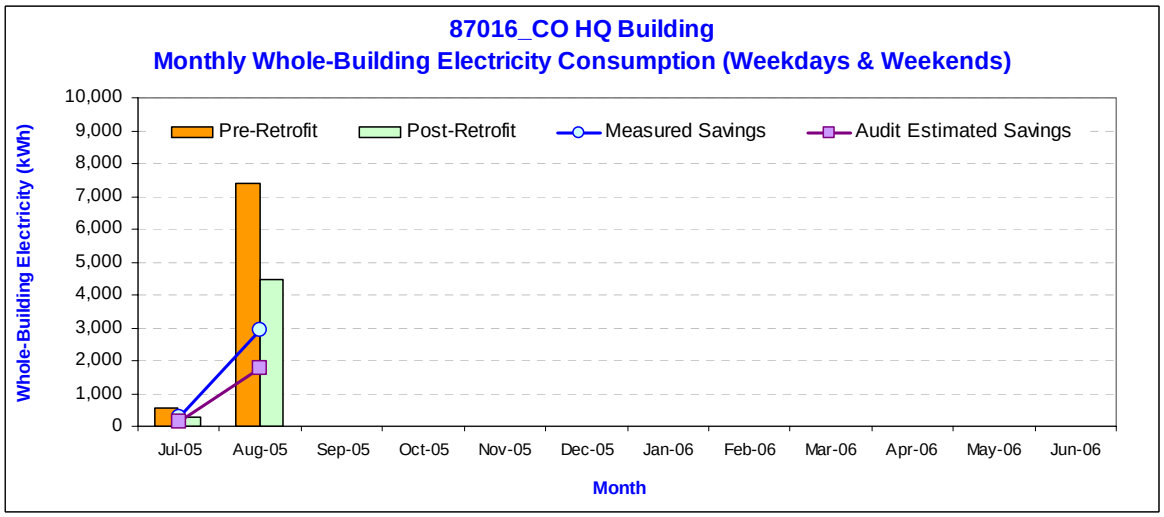

Figure 13.3. 87016 Electricity Savings

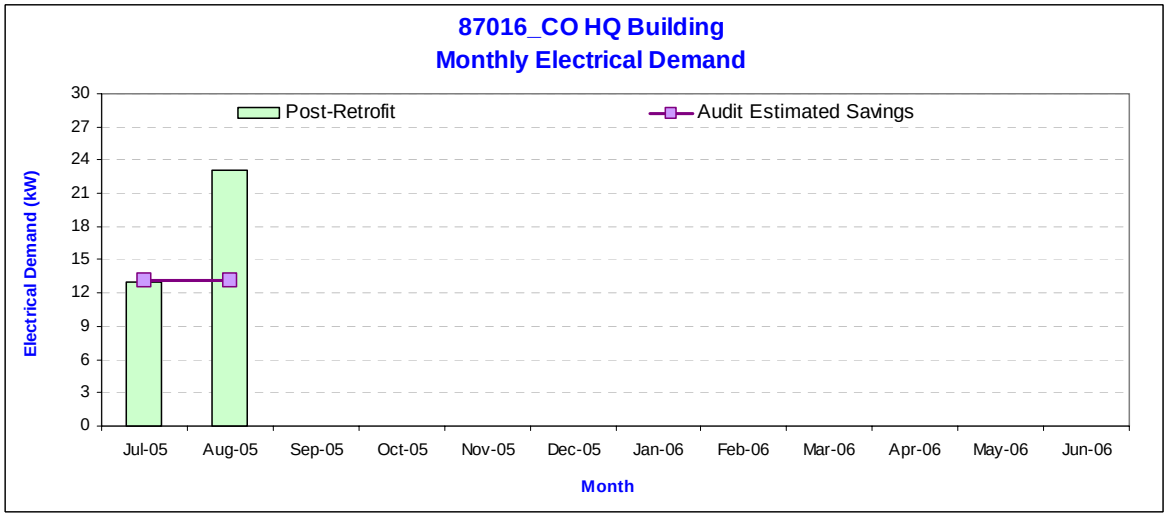

Figure 13.4. 87016 Electrical Demand Savings

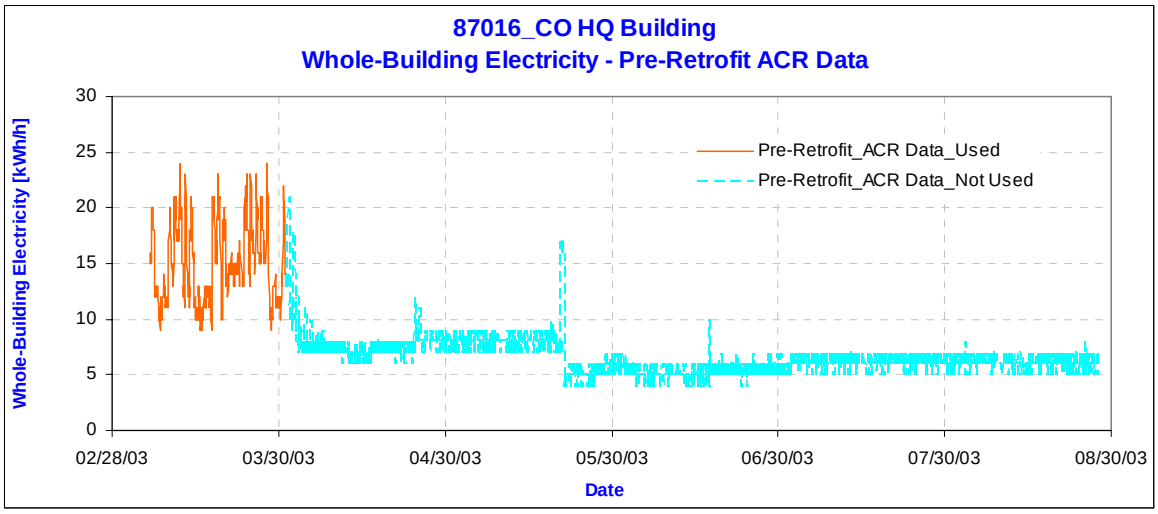

Figure 13.5. 87016 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

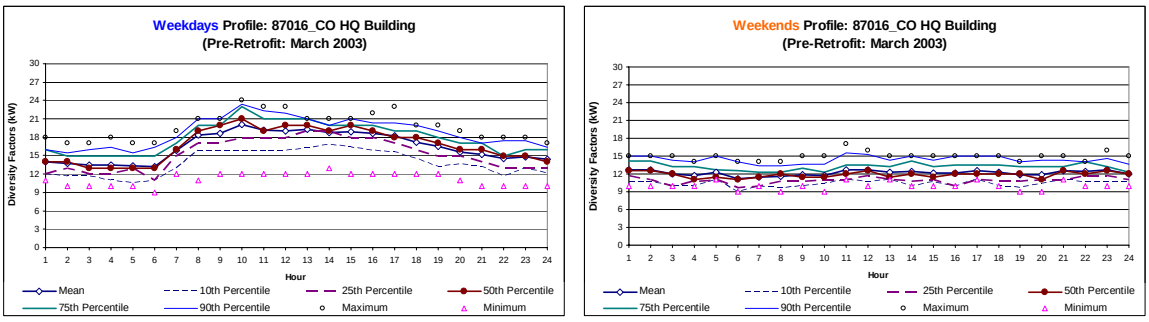

Figure 13.6. 87016 Electrical Demand Model for Pre-retrofit Period

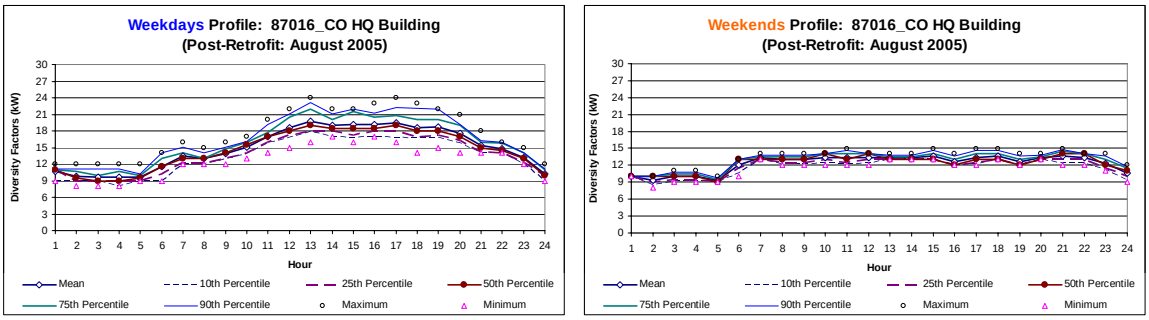

Figure 13.7. 87016 Electrical Demand Model for Post-retrofit Period

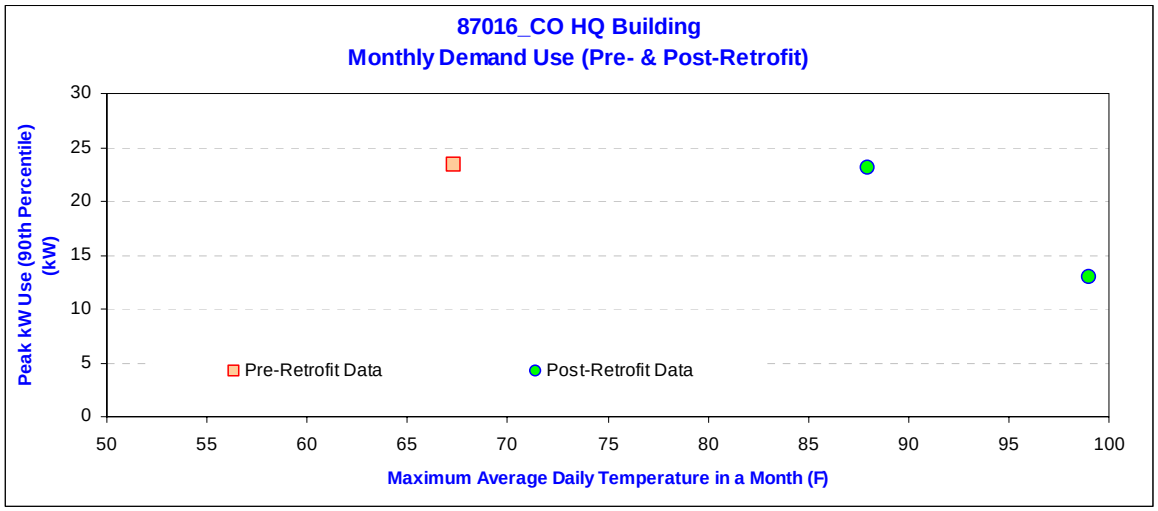

Figure 13.8. 87016 Electrical Demand Use for Pre- and Post-retrofit Periods

14. SAVINGS SUMMARY FOR 87014-CO HQ BUILDING

This section covers the energy and demand savings report for 87014-CO HQ Building of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 32,892 kWh/yr for electricity and 96 kW/yr for electrical demand. As shown in Table 14.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,253 kWh for a total of 25 days correspond to 167.0% of the audit estimated savings. This indicates that the retrofits are generally working better than expected at this building. The total of the monthly demand savings of 24 kW corresponds to 46.2% of the audit estimated savings. This falls short of expectations. Additional information is needed from Fort Hood to identify the reason(s) that the demand savings are not meeting expectations. More measured data are also needed in order to get a more accurate savings analysis.

Figure 14.1 shows the time series plot of the daily electricity use of 87014-CO HQ Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 14.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 14.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented in Figure 14.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

Figure 14.5 shows the hourly ACR data used in the demand analysis for the pre-retrofit period. The 24-hour profiles for weekday and weekend of August 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 14.6 Figure 14.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for August 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 20.3 kW and 19.0 kW, respectively. Therefore, the demand savings for August 2005 is 1.3 kW. In Figure 14.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 14.1. Savings Summary for 87014

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	2	230	180	127.8%
Jul-05	10	1,846	901	204.9%
Aug-05	13	1,687	1,171	144.0%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**25**	**3,763**	**2,253**	**167.0%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	2	1.20	8.01	15.0%
Jul-05	10	8.60	8.01	107.4%
Aug-05	13	1.30	8.01	16.2%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**25**	**11**	**24**	**46.2%**

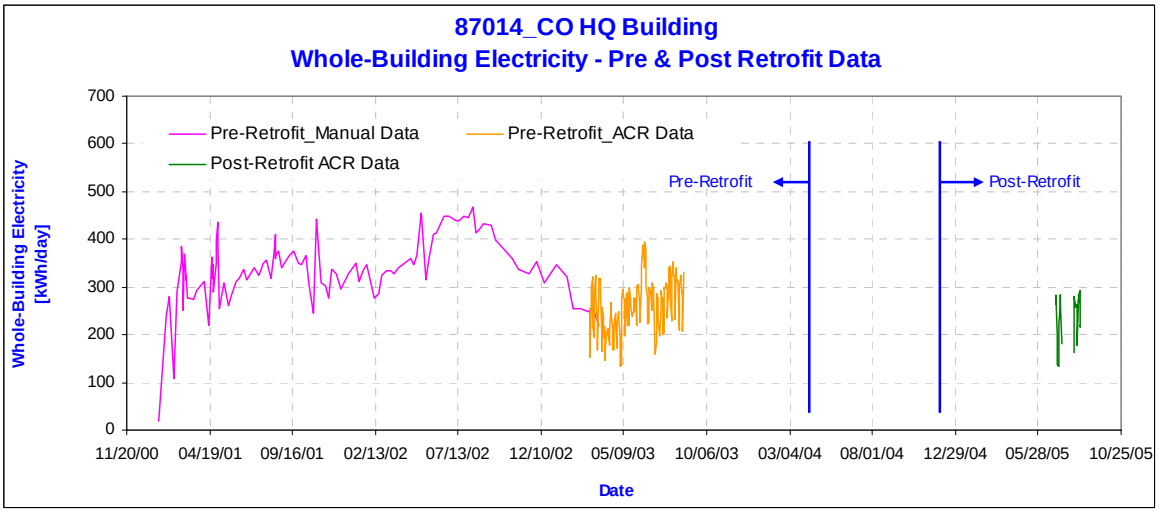

Figure 14.1. 87014 Daily Electricity Use

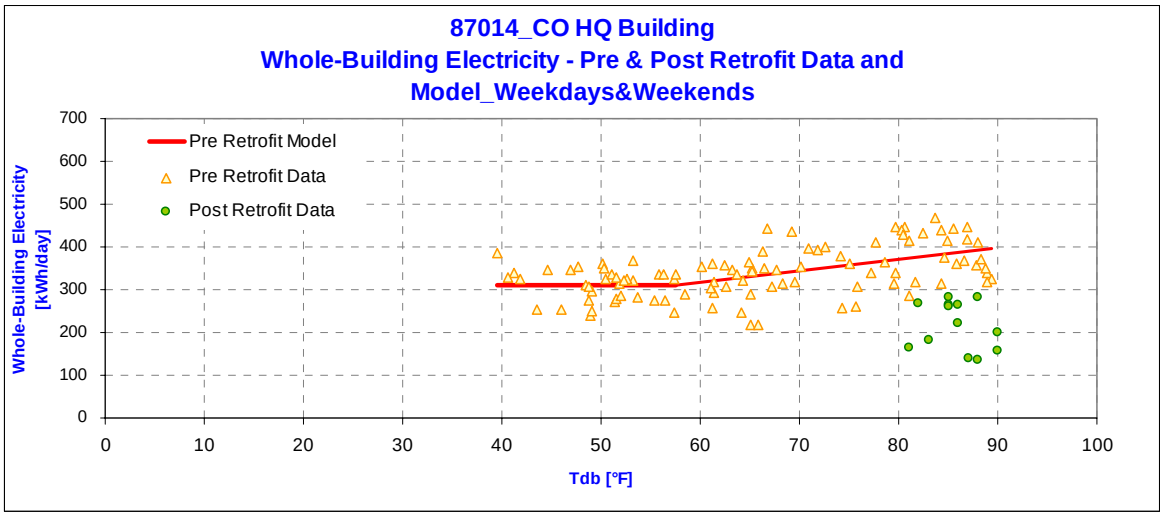

Figure 14.2. 87014 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

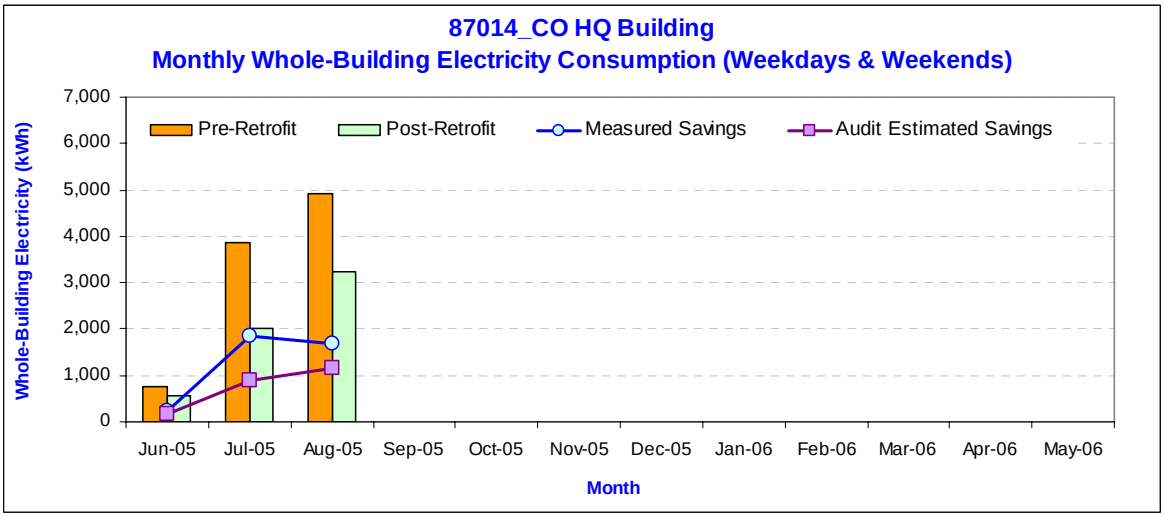

Figure 14.3. 87014 Electricity Savings

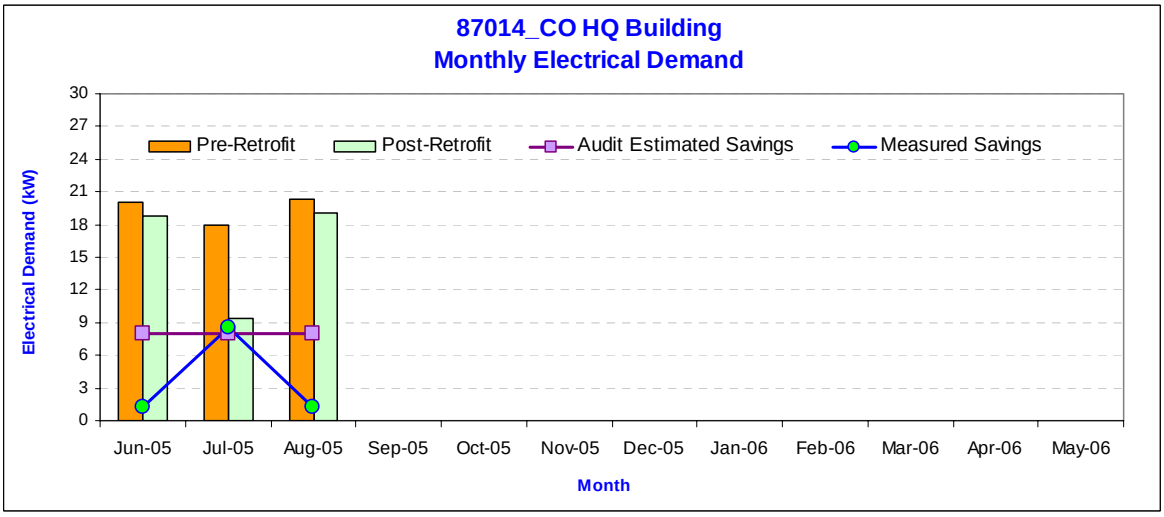

Figure 14.4. 87014 Electrical Demand Savings

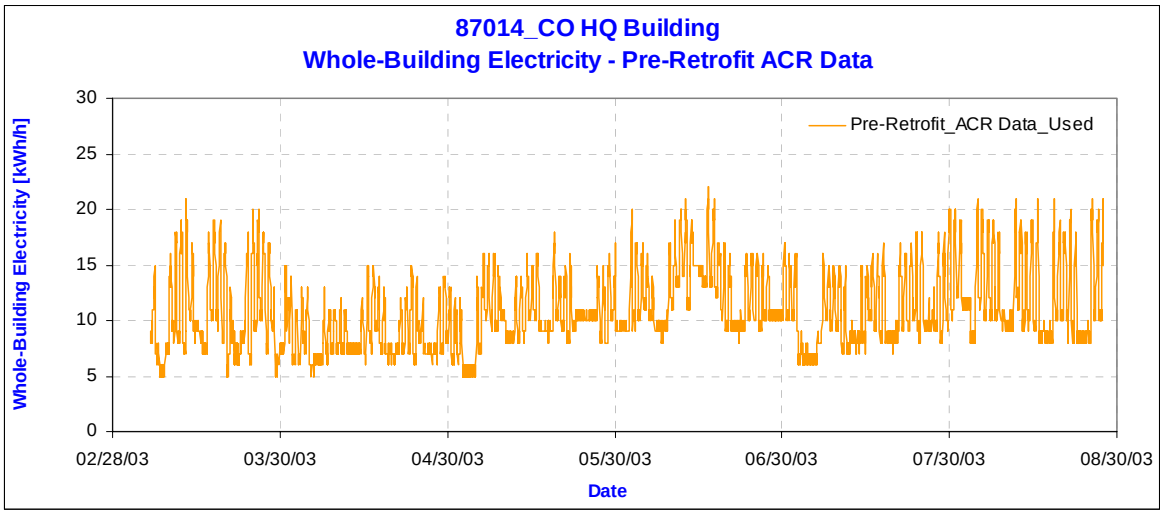

Figure 14.5. 87014 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

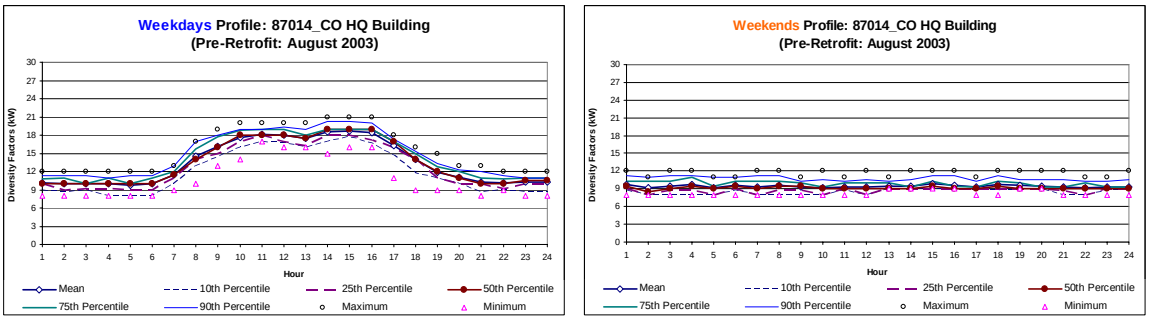

Figure 14.6. 87014 Electrical Demand Model for Pre-retrofit Period

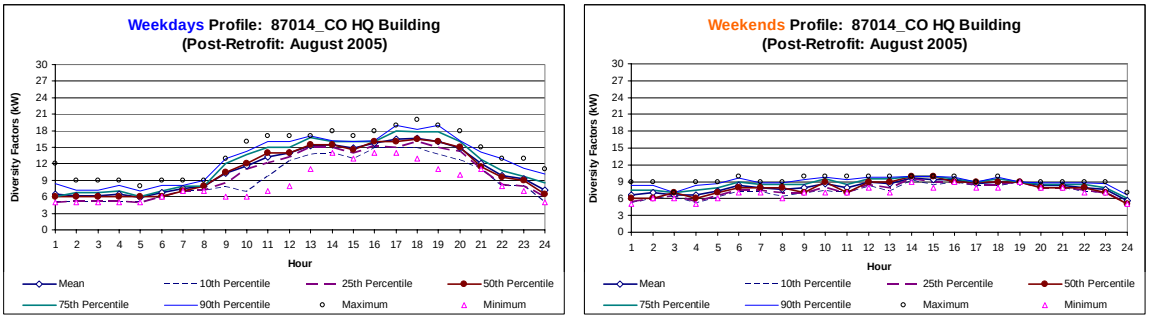

Figure 14.7. 87014 Electrical Demand Model for Post-retrofit Period

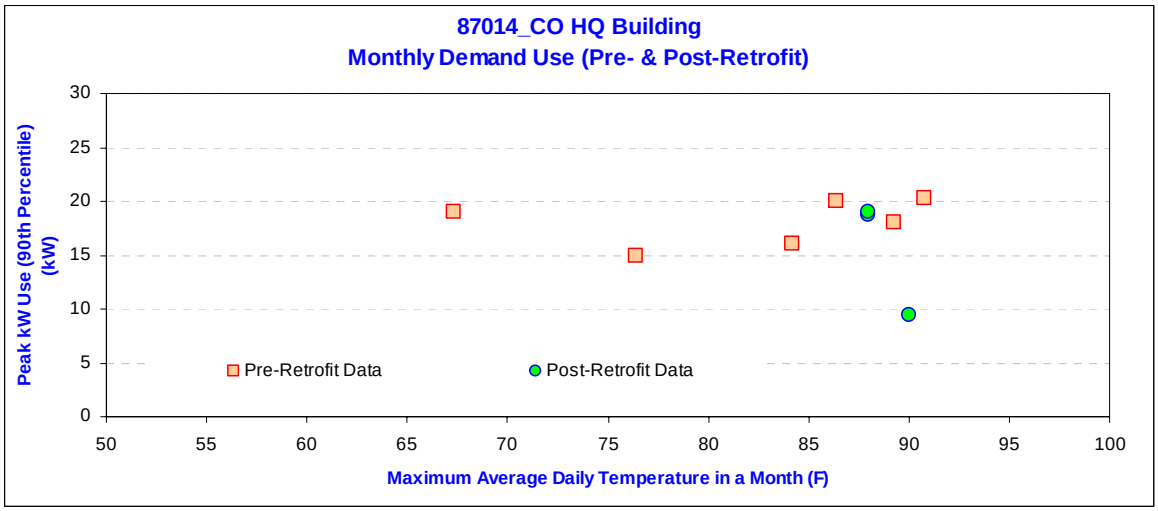

Figure 14.8. 87014 Electrical Demand Use for Pre- and Post-retrofit Periods

15. SAVINGS SUMMARY FOR 87012-ENLISTED UPH

This section covers the energy and demand savings report for 87012-Enlisted UPH Building of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 9,719 kWh/yr for electricity and 5 kW/yr for electrical demand. As shown in Table 15.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 1,366 kWh for a total of 17 days correspond to 301.7% of the audit estimated savings. This indicates that the retrofits are working better than expected at this building. However, additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 15.1 shows the time series plot of the daily electricity use of 87012- Enlisted UPH Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 15.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the two-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 15.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 15.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 15.5, the data for the period of April 1, 2003 to August 26, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 15.6 and Figure 15.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 59.0 kW and 64.1 kW, respectively.

In Figure 15.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. Due to the missing data in the pre-retrofit period compared against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 15.1. Savings Summary for 87012

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	3	163	80	203.7%
Aug-05	14	1,203	373	322.7%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**1,366**	**453**	**301.7%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	3	N/A	0.44	N/A
Aug-05	14	N/A	0.44	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**N/A**	**1**	**N/A**

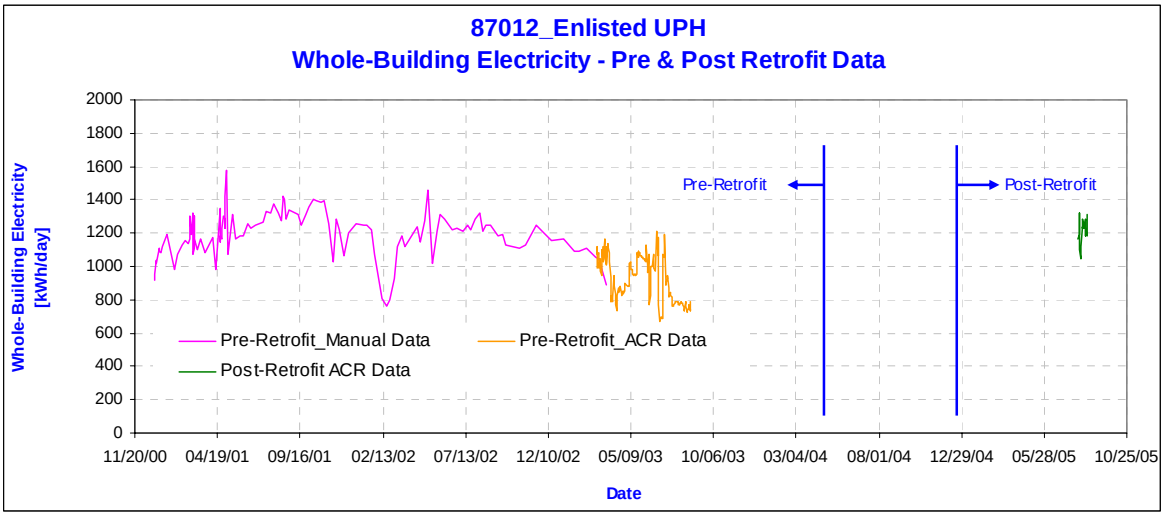

Figure 15.1. 87012 Daily Electricity Use

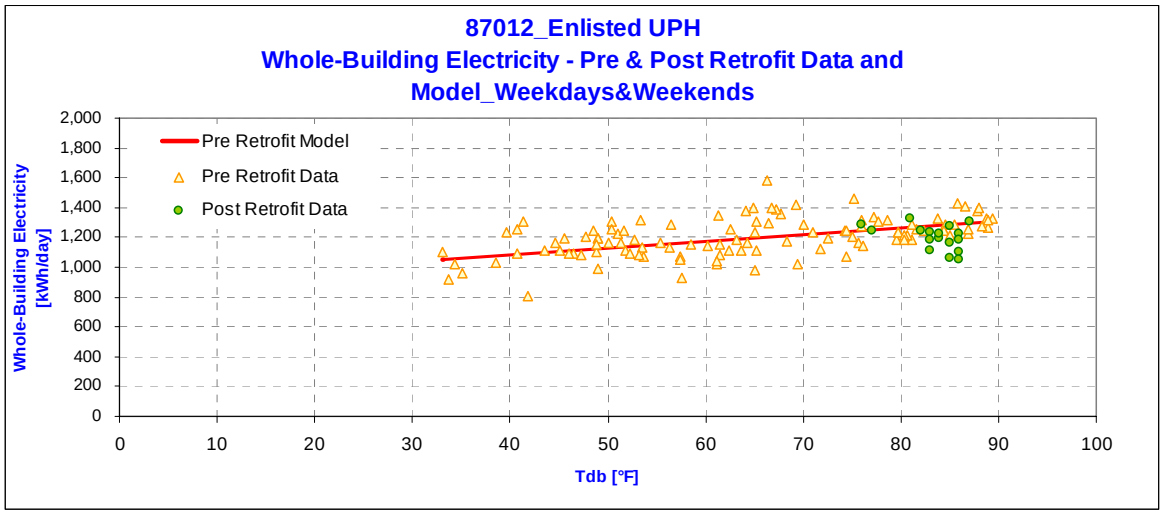

Figure 15.2. 87012 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

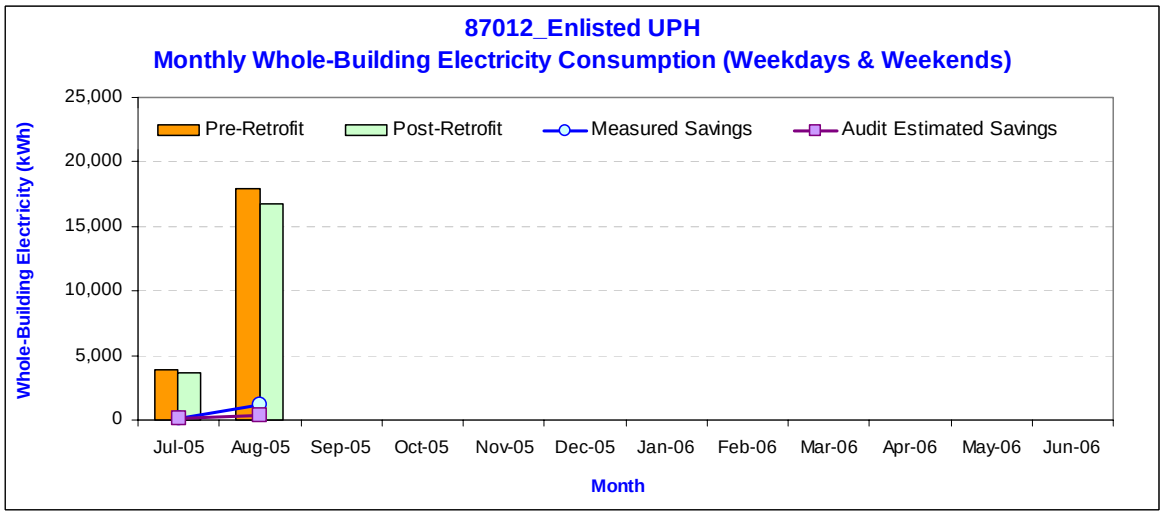

Figure 15.3. 87012 Electricity Savings

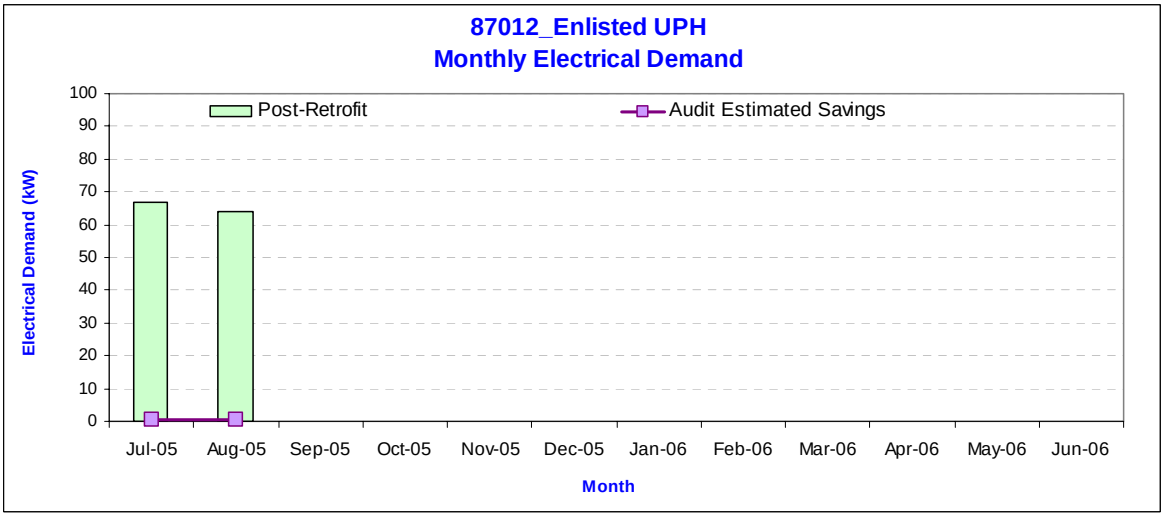

Figure 15.4. 87012 Electrical Demand Savings

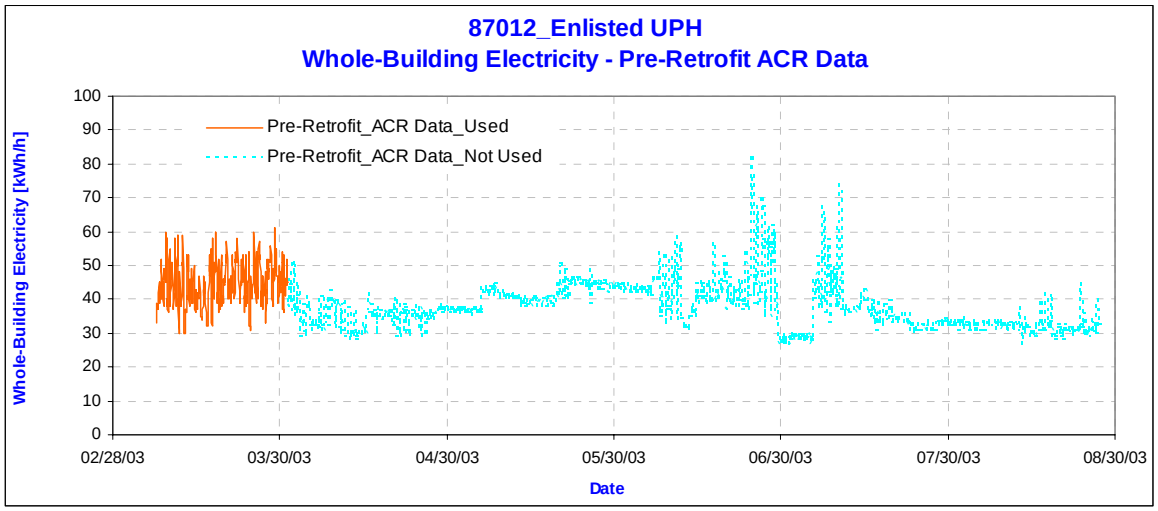

Figure 15.5. 87012 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

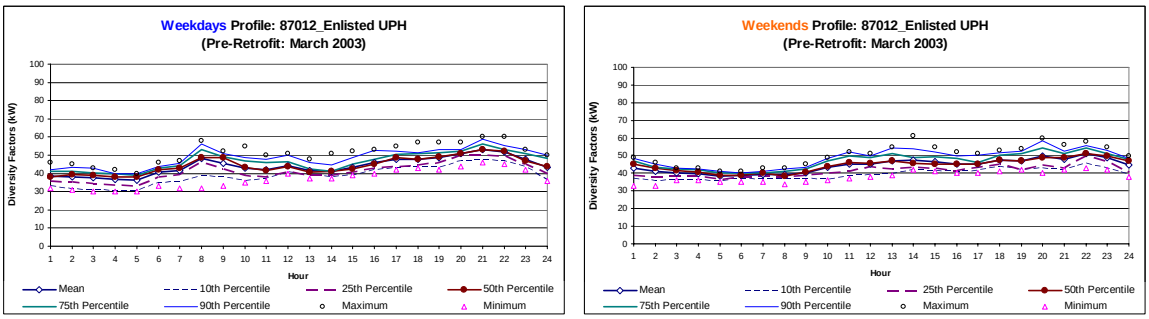

Figure 15.6. 87012 Electrical Demand Model for Pre-retrofit Period

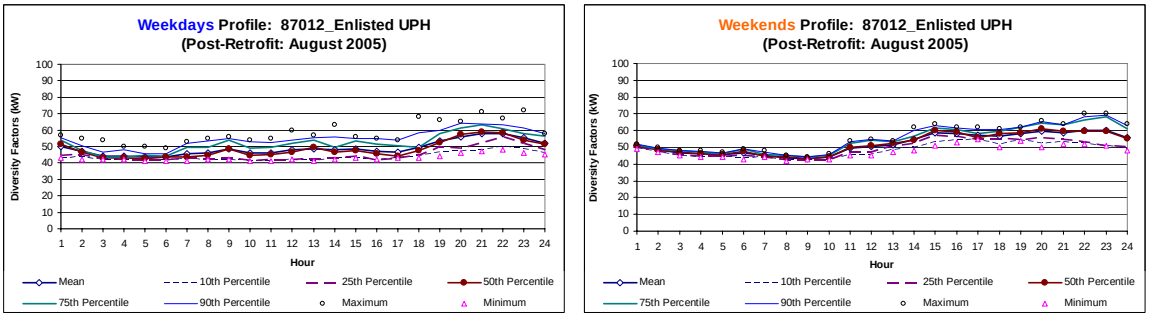

Figure 15.7. 87012 Electrical Demand Model for Post-retrofit Period

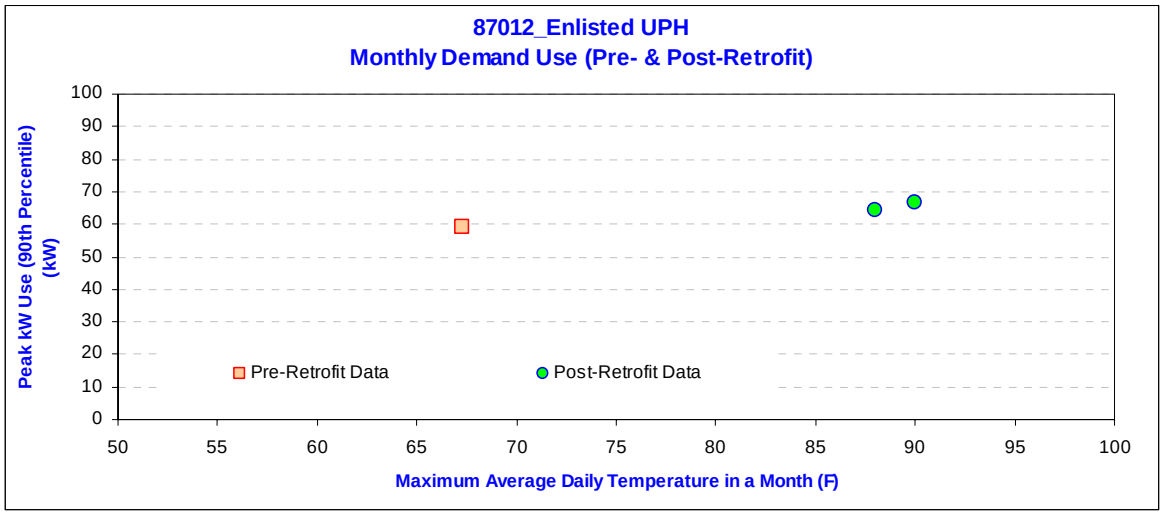

Figure 15.8. 87012 Electrical Demand Use for Pre- and Post-retrofit Periods

16. SAVINGS SUMMARY FOR 87011-CO HQ BUILDING

This section covers the energy and demand savings report for 87011-CO HQ Building of Fort Hood for the period of June 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in December 2004. The audit-estimated savings were 55,680 kWh/yr for electricity and 157 kW/yr for electrical demand. As shown in Table 16.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 2,645 kWh for a total of 28 days correspond to 61.9% of the audit estimated savings. This falls short of expectations. Additional measured data are needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 16.1 shows the time series plot of the daily electricity use of 87011-CO HQ Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of June 2005, July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 16.2. The hourly data for the post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 16.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 16.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 16.5, the data for the period of April 1, 2003 to August 26, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis, it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 16.6 and Figure 16.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 26.0 kW and 30.0 kW, respectively.

In Figure 16.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. Due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 16.1. Savings Summary for 87011

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jun-05	5	253	763	33.1%
Jul-05	10	1,245	1,525	81.6%
Aug-05	13	1,148	1,983	57.9%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**2,645**	**4,271**	**61.9%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jun-05	5	N/A	13.12	N/A
Jul-05	10	N/A	13.12	N/A
Aug-05	13	N/A	13.12	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**28**	**N/A**	**39**	**N/A**

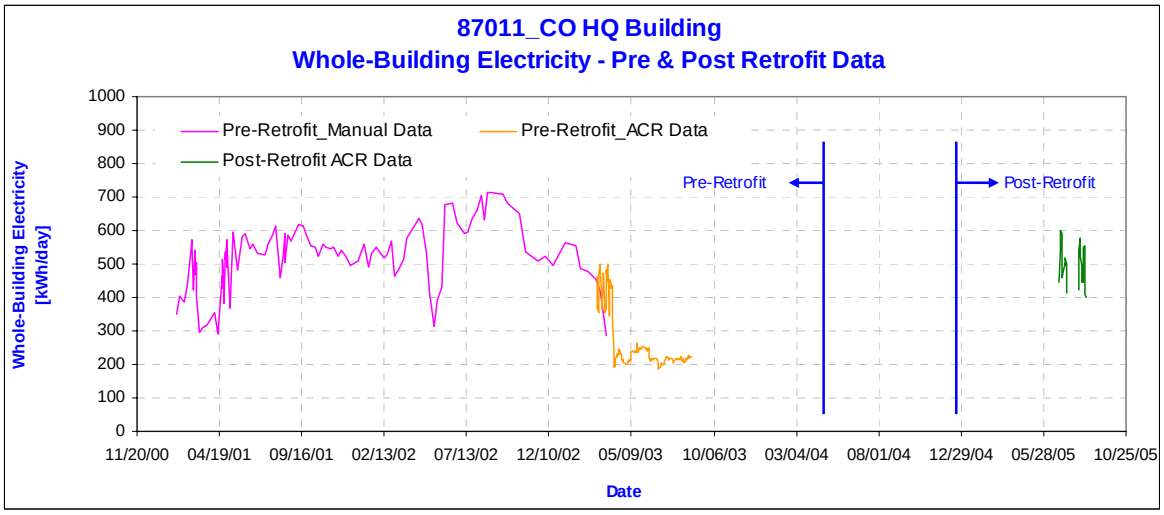

Figure 16.1. 87011 Daily Electricity Use

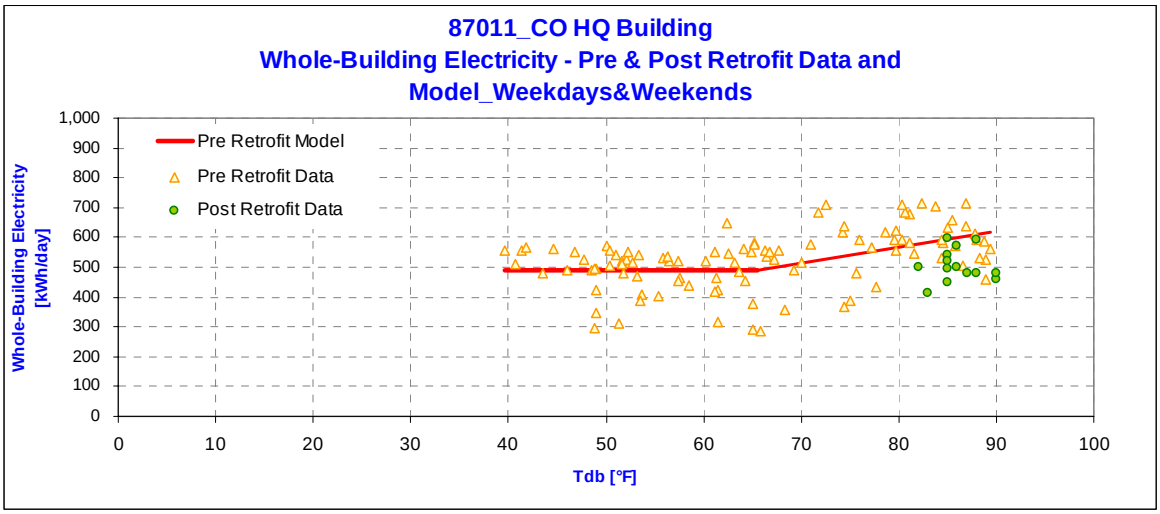

Figure 16.2. 87011 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

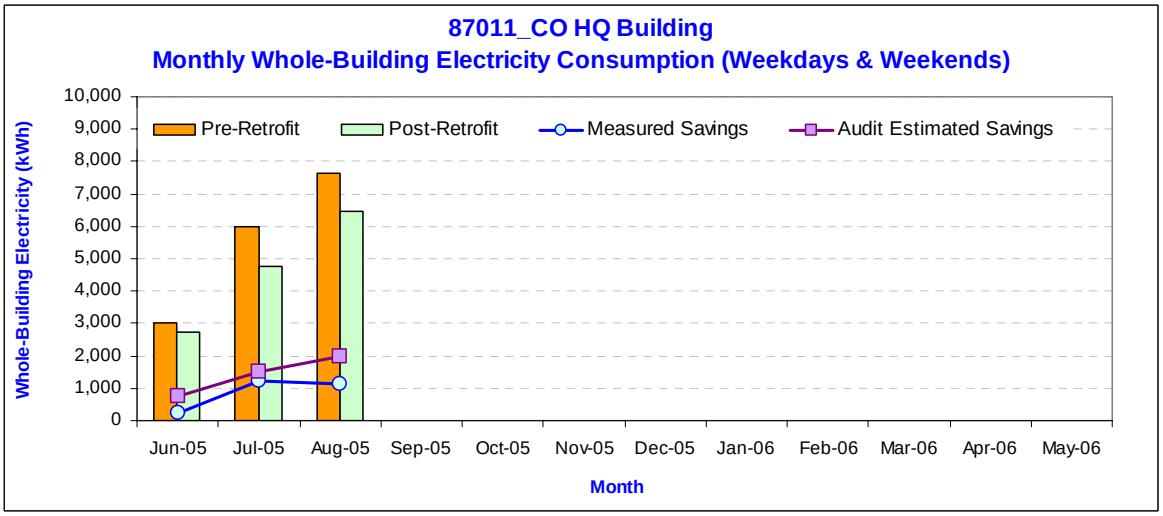

Figure 16.3. 87011 Electricity Savings

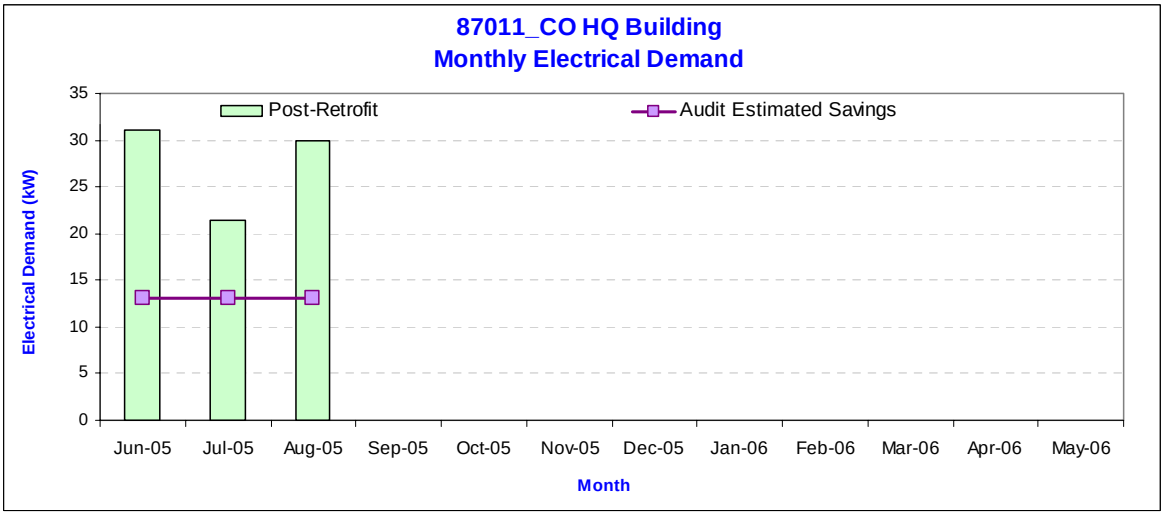

Figure 16.4. 87011 Electrical Demand Savings

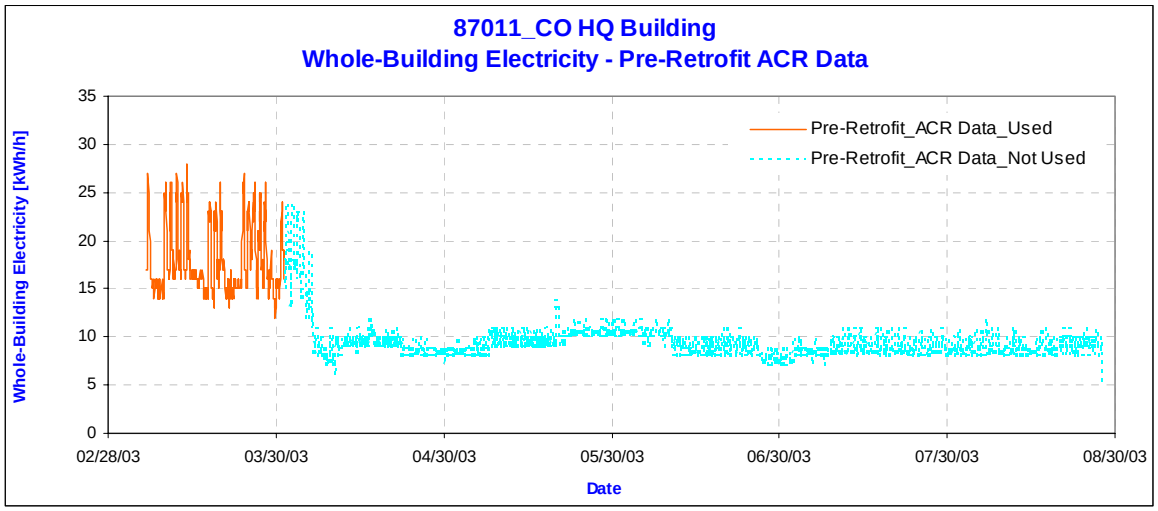

Figure 16.5. 87011 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

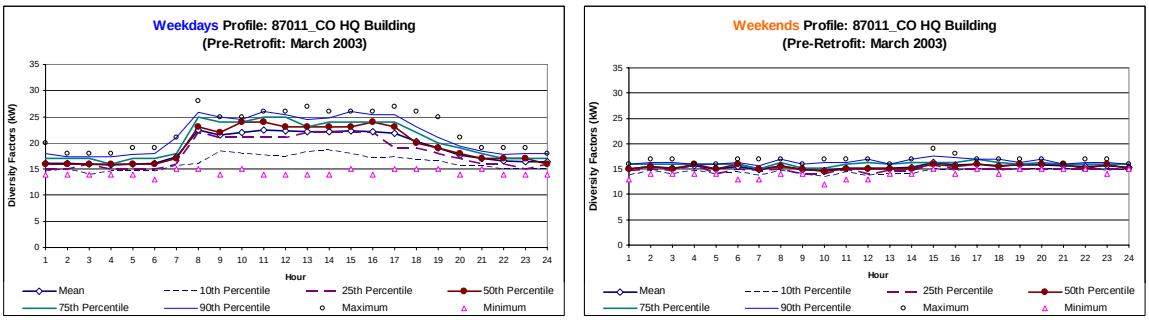

Figure 16.6. 87011 Electrical Demand Model for Pre-retrofit Period

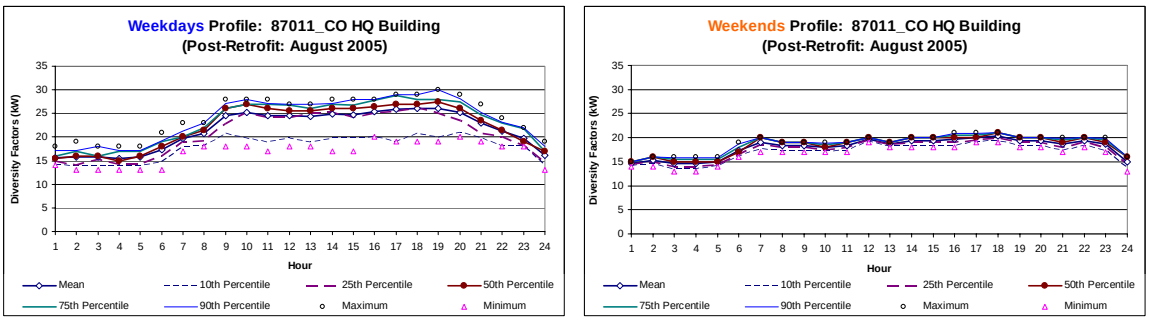

Figure 16.7. 87011 Electrical Demand Model for Post-retrofit Period

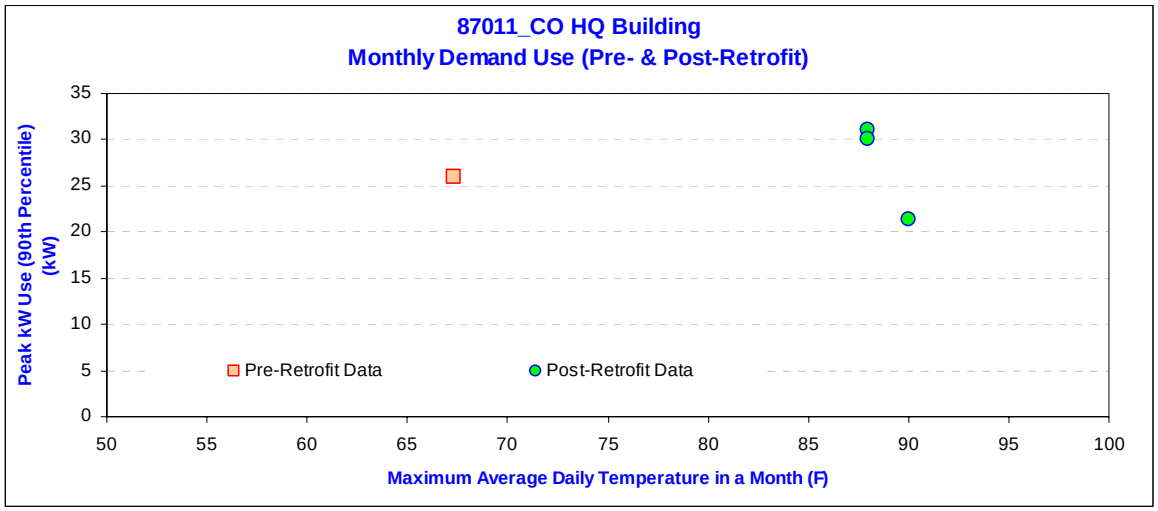

Figure 16.8. 87011 Electrical Demand Use for Pre- and Post-retrofit Periods

17. SAVINGS SUMMARY FOR 87015-ENLISTED UPH

This section covers the energy and demand savings report for 87015-Enlisted UPH Building of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 6,502 kWh/yr for electricity and 3 kW/yr for electrical demand. As shown in Table 17.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity consumption savings of -849 kWh, for a total of 17 days, correspond to an increase in electricity consumption for the building. This falls short of expectations. Additional information is needed from Fort Hood to identify the reason(s) that the electricity savings are not meeting expectations. More measured data are also needed in order to get a more accurate savings analysis. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 17.1 shows the time series plot of the daily electricity use of 87015-Enlisted UPH Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through May 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 17.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 17.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 17.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

As shown in Figure 17.5, the data for the period of April 1, 2003 to May 12, 2003 were excluded in the demand analysis because the usage appears to be low due to the deployment of the troops in this period. If these data are included in the analysis it will lower the savings. The 24-hour profiles for weekday and weekend of March 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 17.6 and Figure 17.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for March 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 23.2 kW and 27.7 kW, respectively.

In Figure 17.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. Due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 17.1. Savings Summary for 87015

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	3	-58	53	-108.5%
Aug-05	14	-791	249	-317.0%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**-849**	**303**	**-280.2%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	3	N/A	0.29	N/A
Aug-05	14	N/A	0.29	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**N/A**	**0.6**	**N/A**

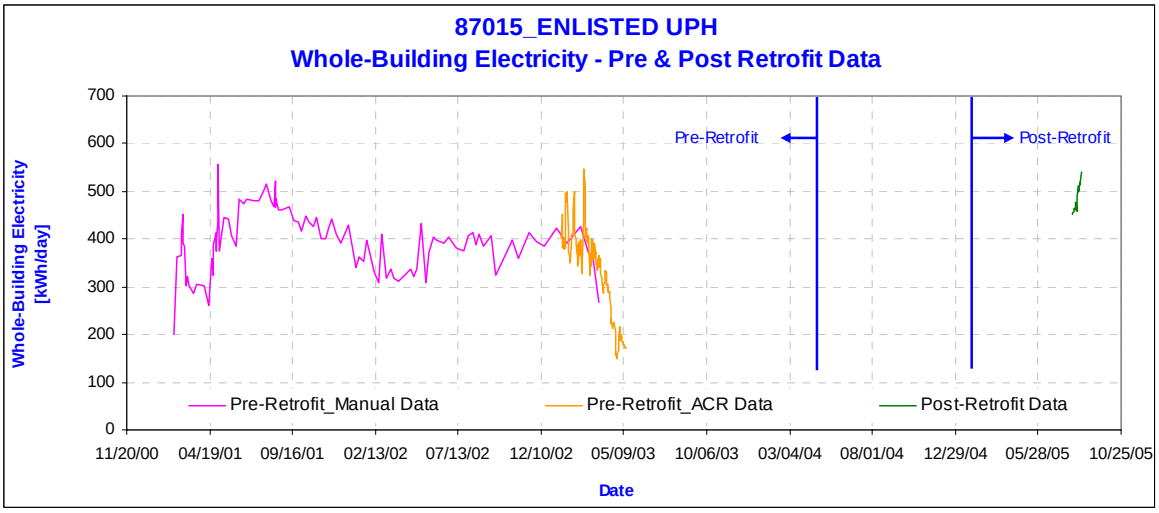

Figure 17.1. 87015 Daily Electricity Use

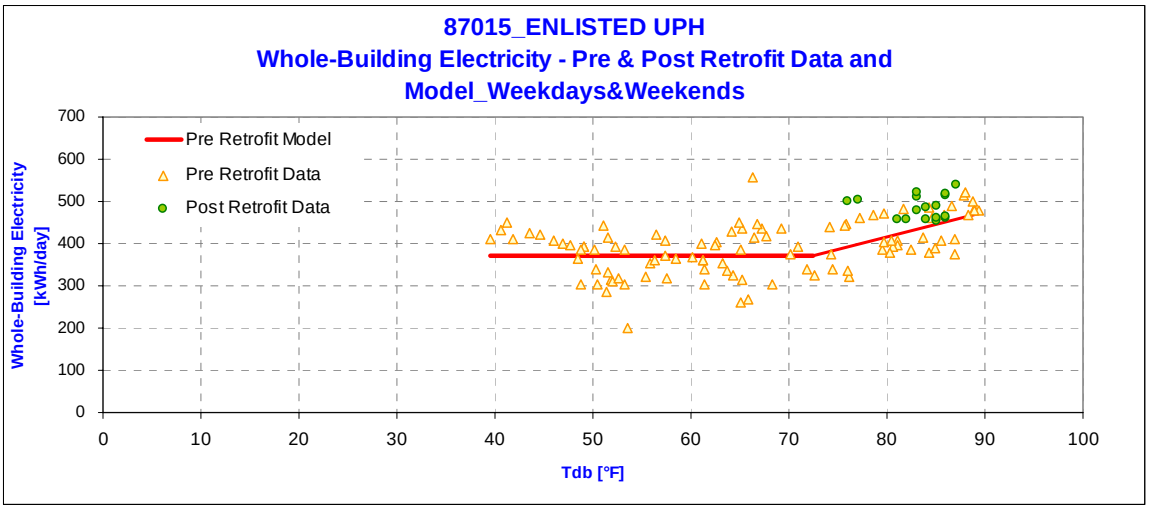

Figure 17.2. 87015 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

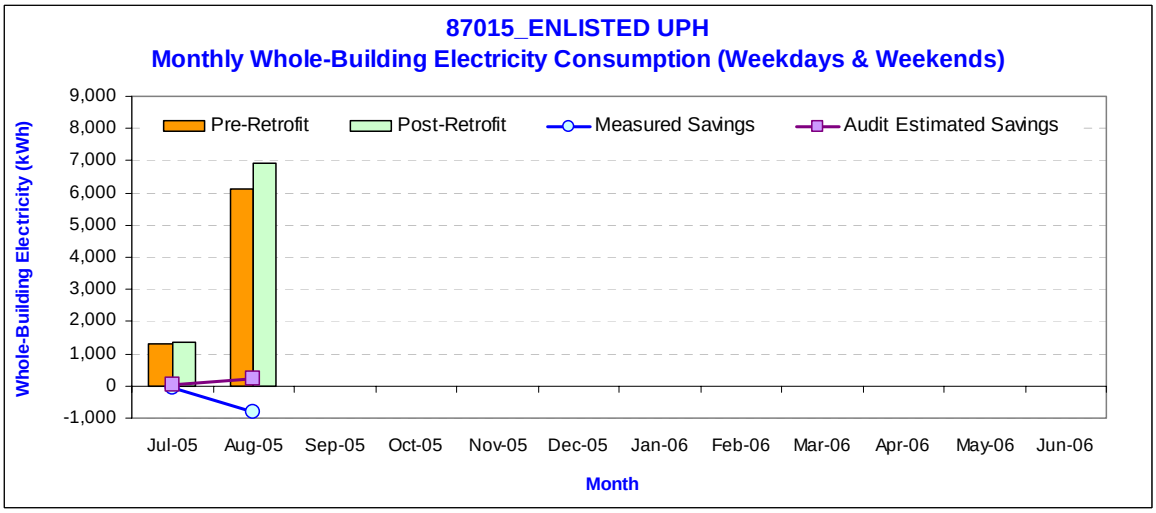

Figure 17.3. 87015 Electricity Savings

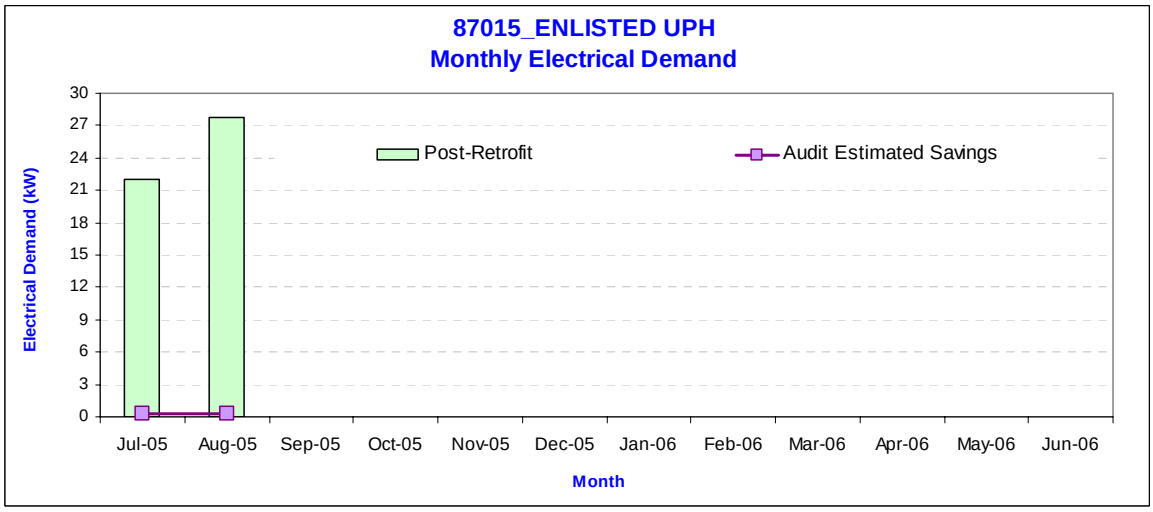

Figure 17.4. 87015 Electrical Demand Savings

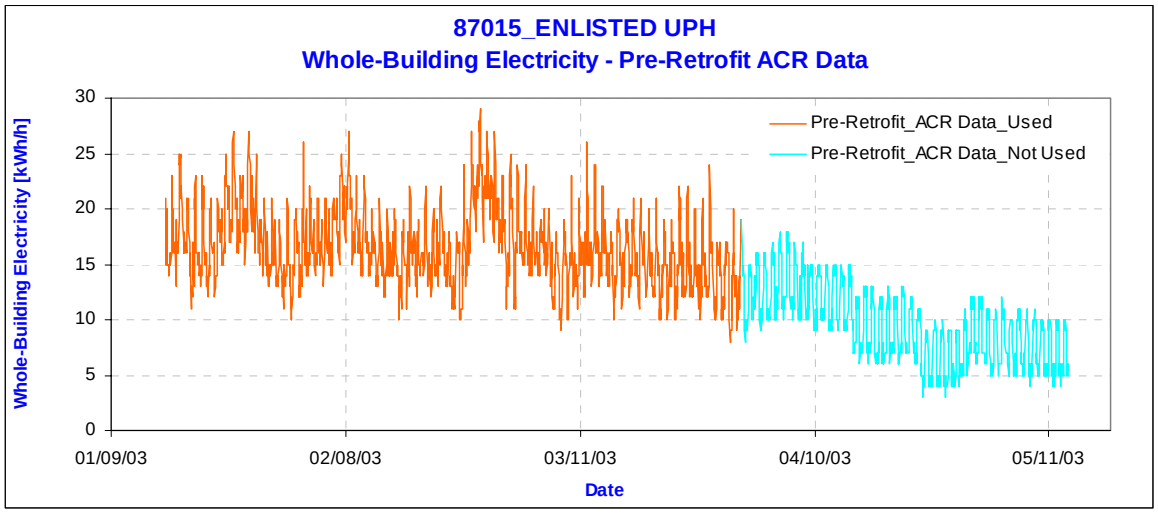

Figure 17.5. 87015 Hourly ACR Data for the Pre-Retrofit Period (January 2003 to May 2003)

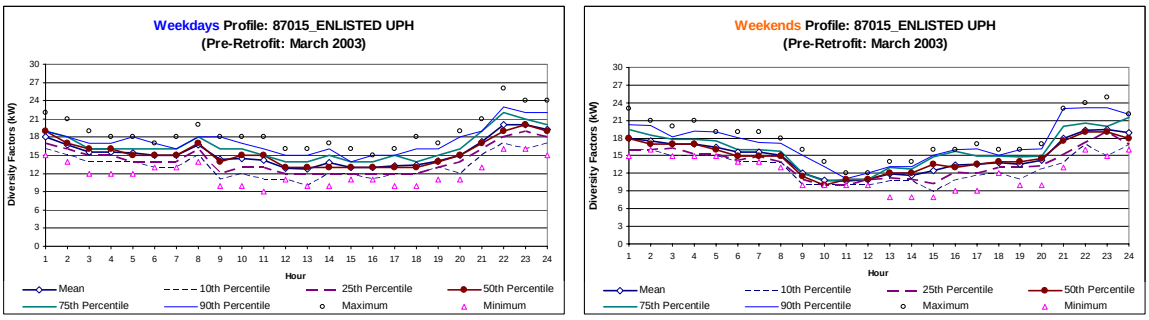

Figure 17.6. 87015 Electrical Demand Model for Pre-retrofit Period

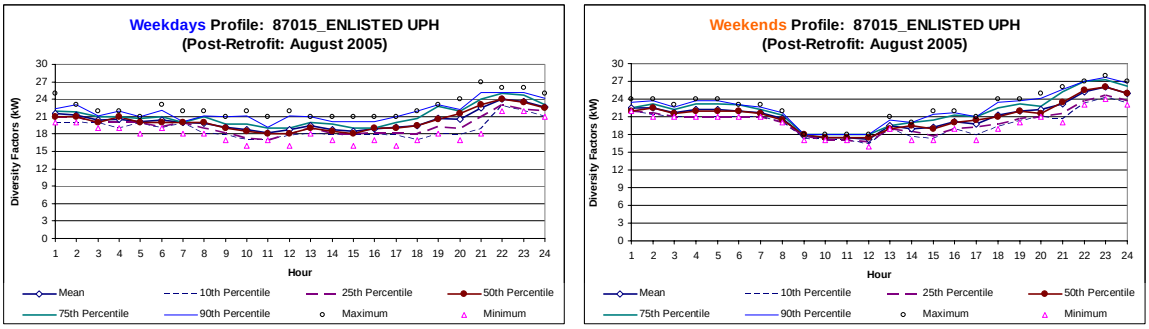

Figure 17.7. 87015 Electrical Demand Model for Post-retrofit Period

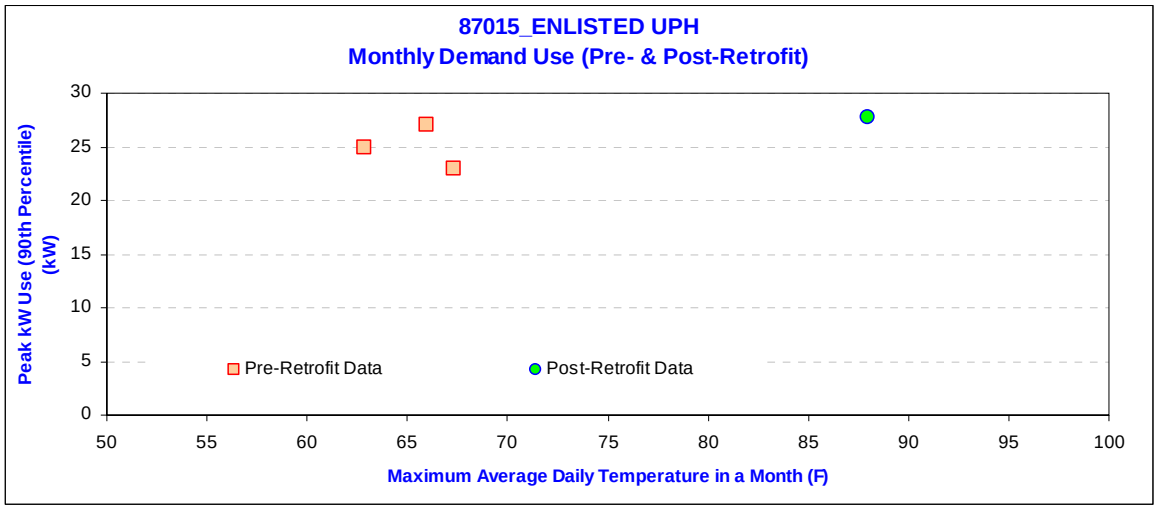

Figure 17.8. 87015 Electrical Demand Use for Pre- and Post-retrofit Periods

18. SAVINGS SUMMARY FOR 87007-ENLISTED UPH

This section covers the energy and demand savings report for 87007-Enlisted UPH Building of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 5,887kWh/yr for electricity. As shown in Table 18.1, the monthly audit estimated savings for electricity is proportional to the number of days per month. The measured electricity consumption savings of -315 kWh, for a total of 17 days, correspond to an increase in electricity consumption for the building. This falls short of expectations. Additional information is needed from Fort Hood to identify the reason(s) that the electricity savings are not meeting expectations. More measured data are also needed in order to get a more accurate savings analysis. The demand savings were not calculated because no demand savings were expected in this building.

Figure 18.1 shows the time series plot of the daily electricity use of 87007 Enlisted UPH Building for the period of December 2000 through October 2003 (manual reading data), May 2002 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 18.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the four-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 18.3.

The electrical demand for post-retrofit periods is presented in Figure 18.4. No electrical demand savings were expected for this building. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate the demand use. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

Figure 18.5 shows the hourly ACR data used in the demand analysis for the pre-retrofit period. It appears there was an operational change during the period April 2003 to July 2003. The 24-hour profiles for weekday and weekend of August 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 18.6 and Figure 18.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for August 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 46.3 kW and 54.1 kW, respectively. In Figure 18.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. It appears no demand savings were achieved in this building.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 18.1. Savings Summary for 87007

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	3	-48	48	-99.9%
Aug-05	14	-266	226	-118.0%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**-315**	**274**	**-114.8%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	3	N/A	0.00	N/A
Aug-05	14	N/A	0.00	N/A
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Jun-06				
Total	**17**	**N/A**	**0**	**N/A**

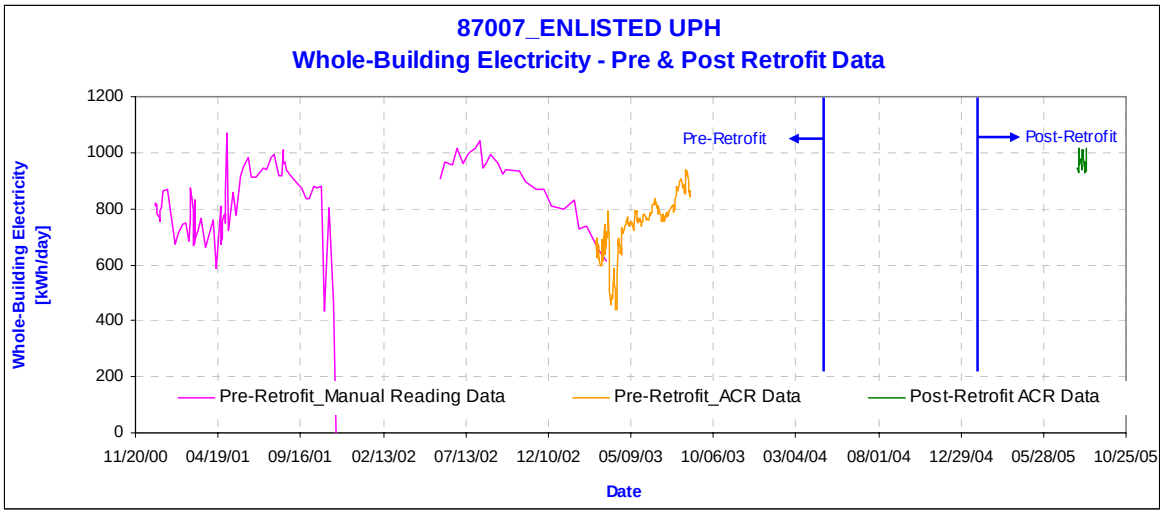

Figure 18.1. 87007 Daily Electricity Use

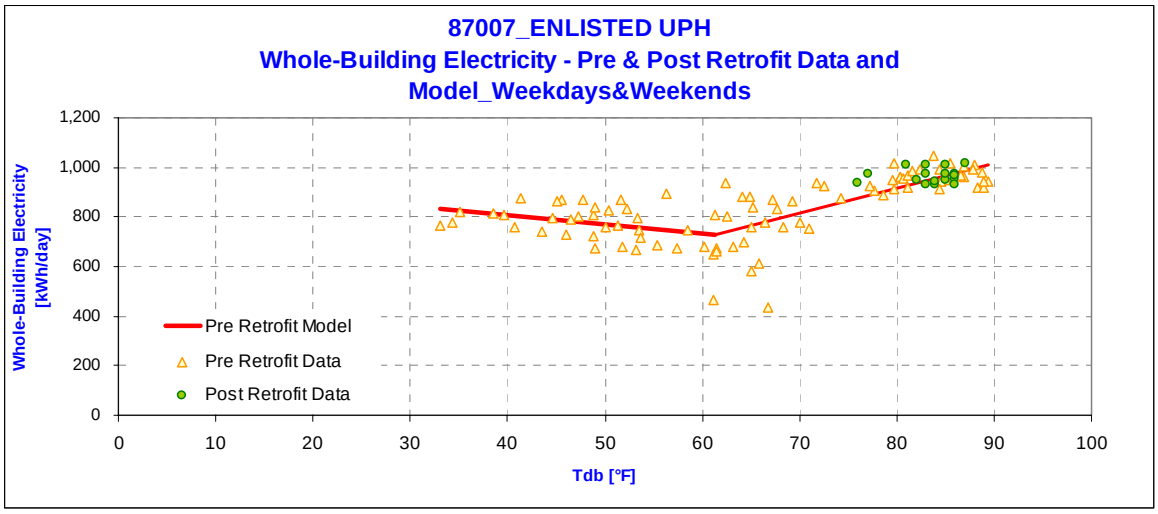

Figure 18.2. 87007 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

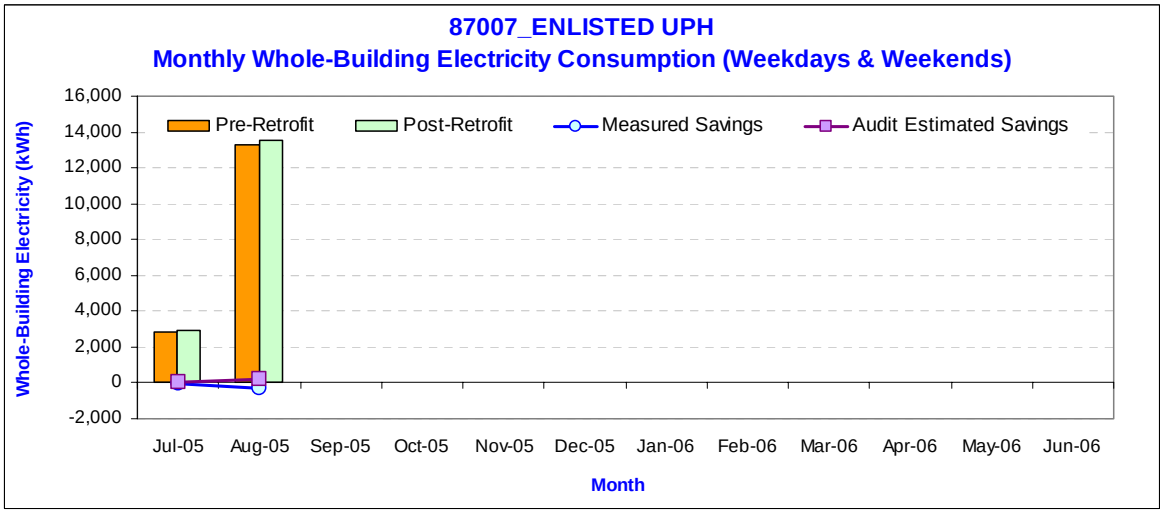

Figure 18.3. 87007 Electricity Savings

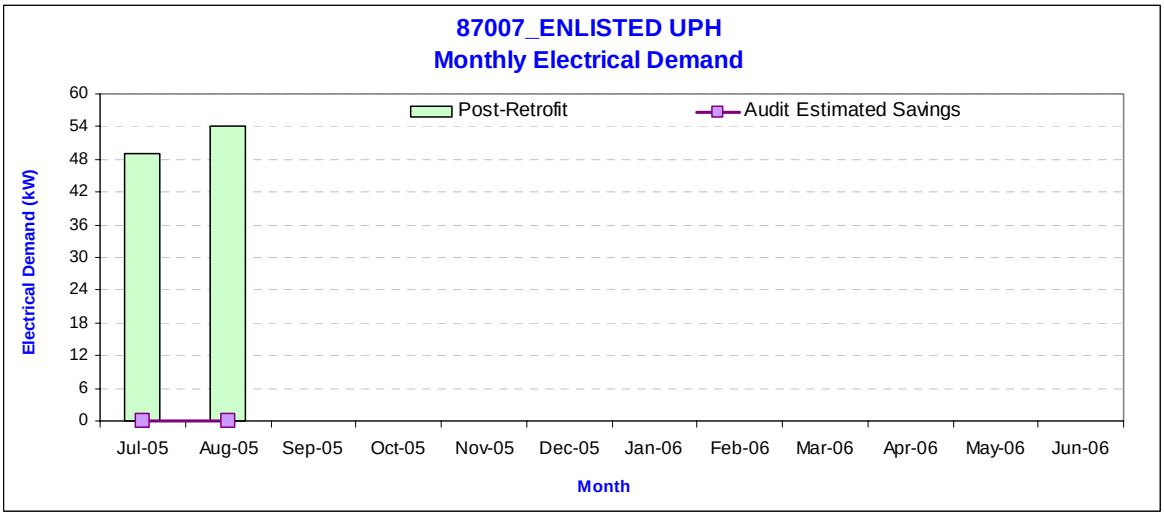

Figure 18.4. 87007 Electrical Demand Savings

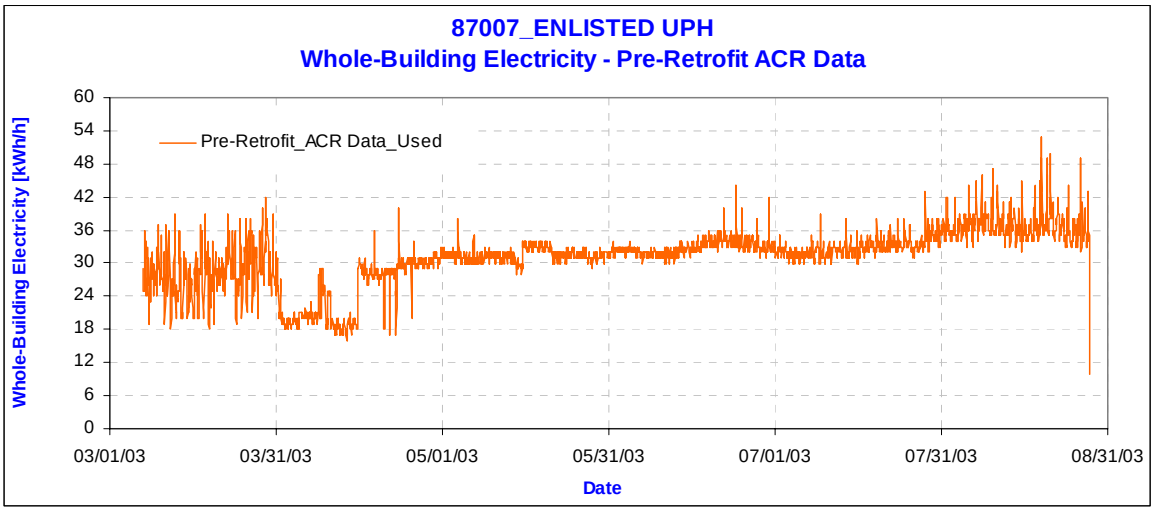

Figure 18.5. 87007 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

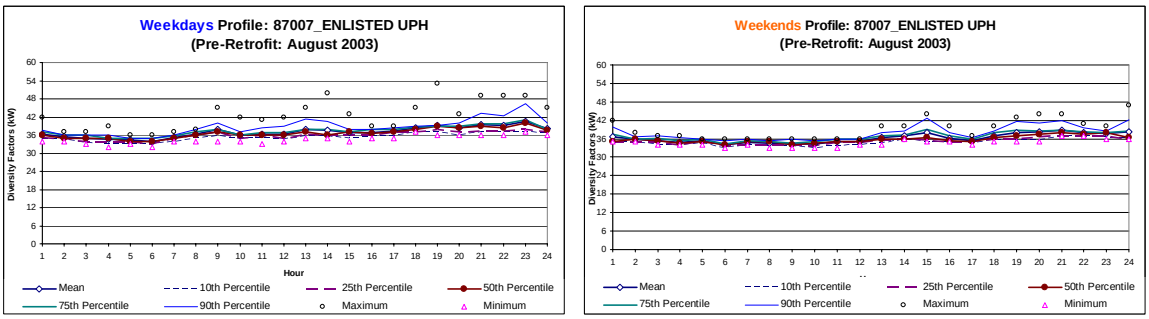

Figure 18.6. 87007 Electrical Demand Model for Pre-retrofit Period

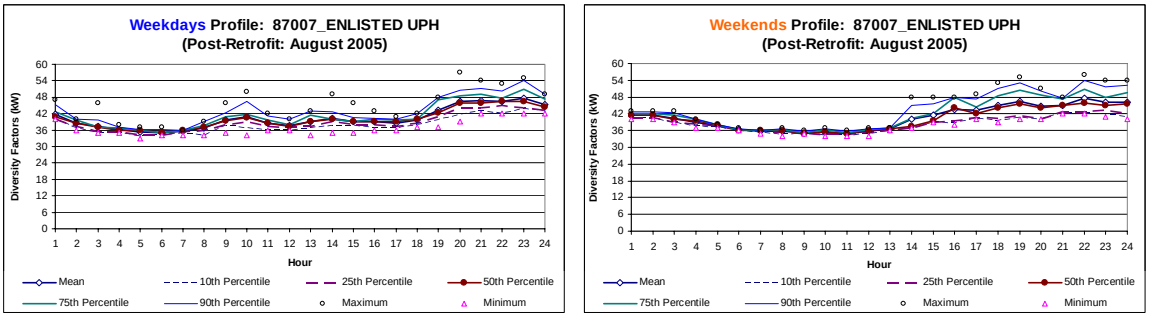

Figure 18.7. 87007 Electrical Demand Model for Post-retrofit Period

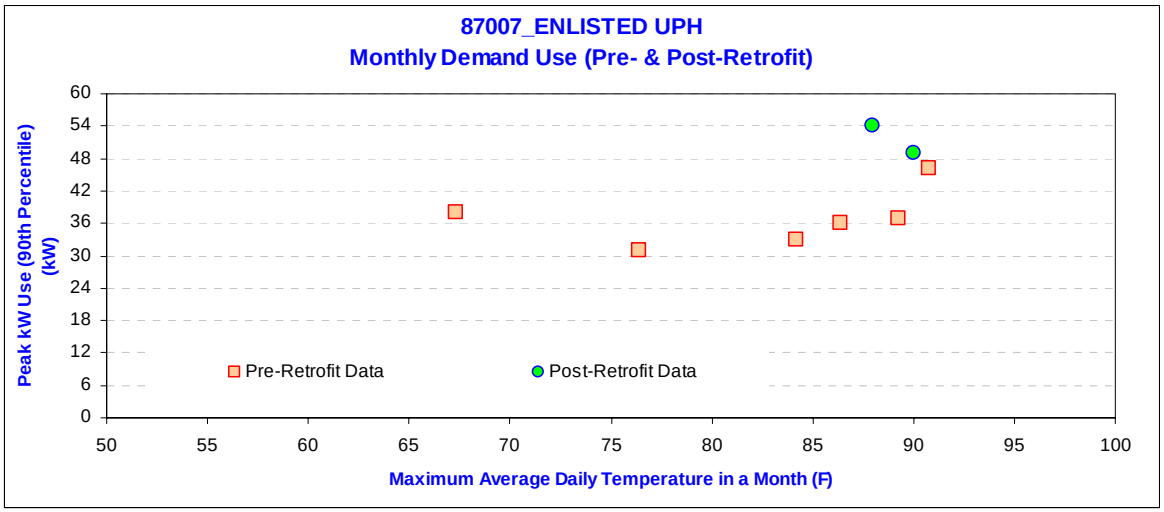

Figure 18.8. 87007 Electrical Demand Use for Pre- and Post-retrofit Periods

19. SAVINGS SUMMARY FOR 87005-BDE HQ BUILDING

This section covers the energy and demand savings report for 87005-BDE HQ Building of Fort Hood for the period of July 2005 – August 2005. According to the information obtained from Fort Hood, lighting and HVAC controls were implemented at this site. The lighting project was completed in April 2004 and the HVAC controls project was completed in January 2005. The audit-estimated savings were 26, 450 kWh/yr for electricity and 114 kW/yr for electrical demand. As shown in Table 19.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity consumption savings of 1,221 kWh, for a total of 14 days, correspond to 120.3% of the audit estimated savings. The total of the monthly demand savings of 10 kW corresponds to 62.1% of the audit estimated savings. This falls short of expectations. Additional information is needed from Fort Hood to identify the reason(s) that the demand savings are not meeting expectations. More measured data are also needed in order to get a more accurate savings analysis.

Figure 19.1 shows the time series plot of the daily electricity use of 87005-BDE HQ Building for the period of December 2000 through March 2003 (manual reading data), March 2003 through August 2003 (ACR logger data), and part of July 2005 and August 2005 (ACR logger data). The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The manual reading data collected for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 19.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 19.3.

The monthly electrical demand for pre- and post-retrofit periods and the electrical demand savings are presented Figure 19.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used to evaluate the demand use. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

Figure 19.5 shows the hourly ACR data used in the demand analysis for the pre-retrofit period. The 24-hour profiles for weekday and weekend of August 2003 (Pre-retrofit) and August 2005 (Post-retrofit), developed from measured data, are displayed in Figure 19.6 and Figure 19.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for August 2003 (Pre-retrofit) and August 2005 (Post-retrofit) are 35.0 kW and 29.1 kW, respectively. Therefore, the demand savings for August 2005 is 5.9 kW. In Figure 19.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 19.1. Savings Summary for 87005

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jul-05	1	-56	72	-77.3%
Aug-05	13	1,277	942	135.5%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**14**	**1,221**	**1,015**	**120.3%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jul-05	1	N/A	9.50	N/A
Aug-05	13	5.90	9.50	62.1%
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
May-06				
Total	**13**	**6**	**10**	**62.1%**

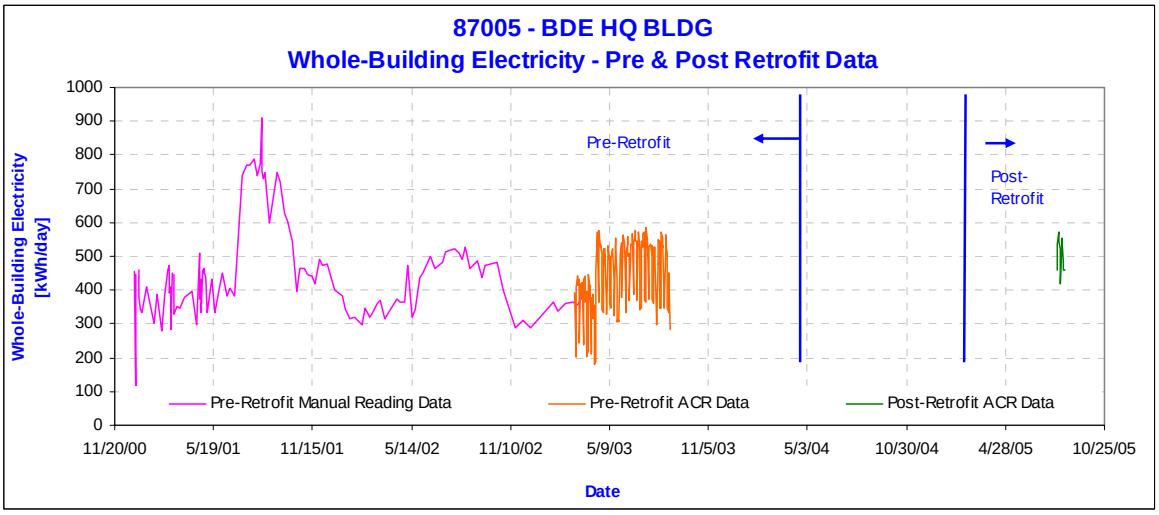

Figure 19.1. 87005 Daily Electricity Use

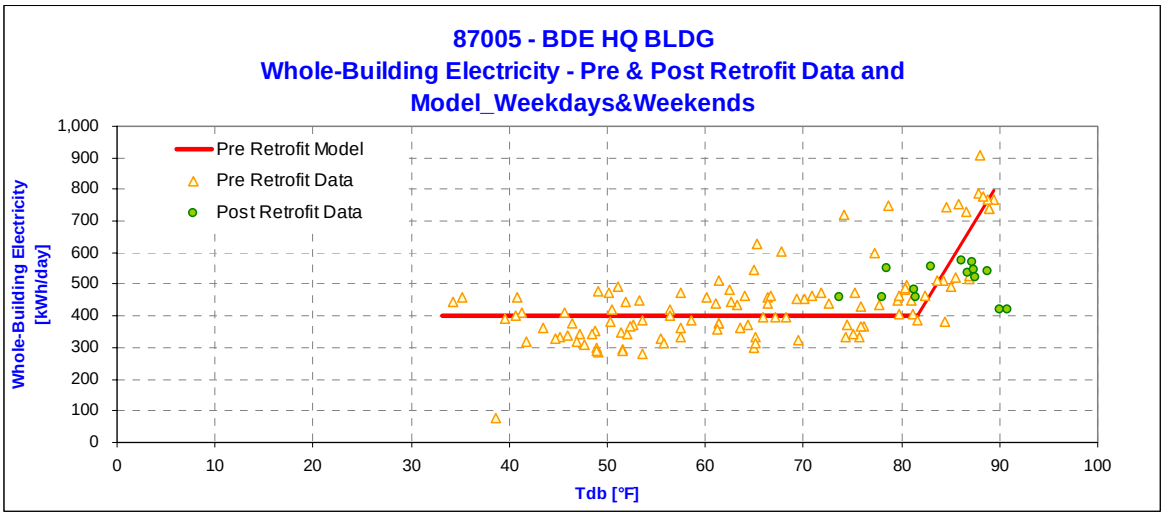

Figure 19.2. 87005 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

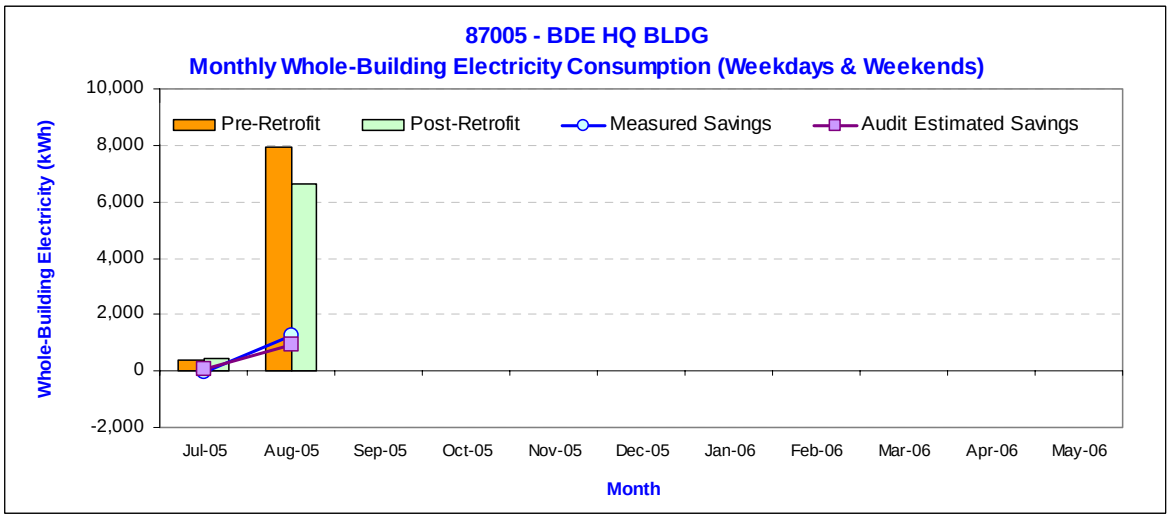

Figure 19.3. 87005 Electricity Savings

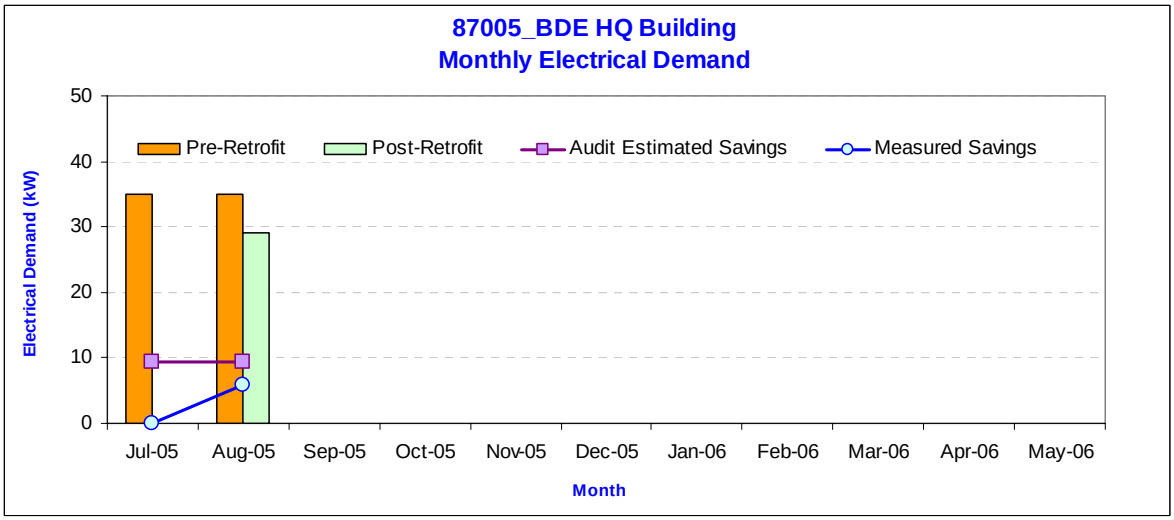

Figure 19.4. 87005 Electrical Demand Savings

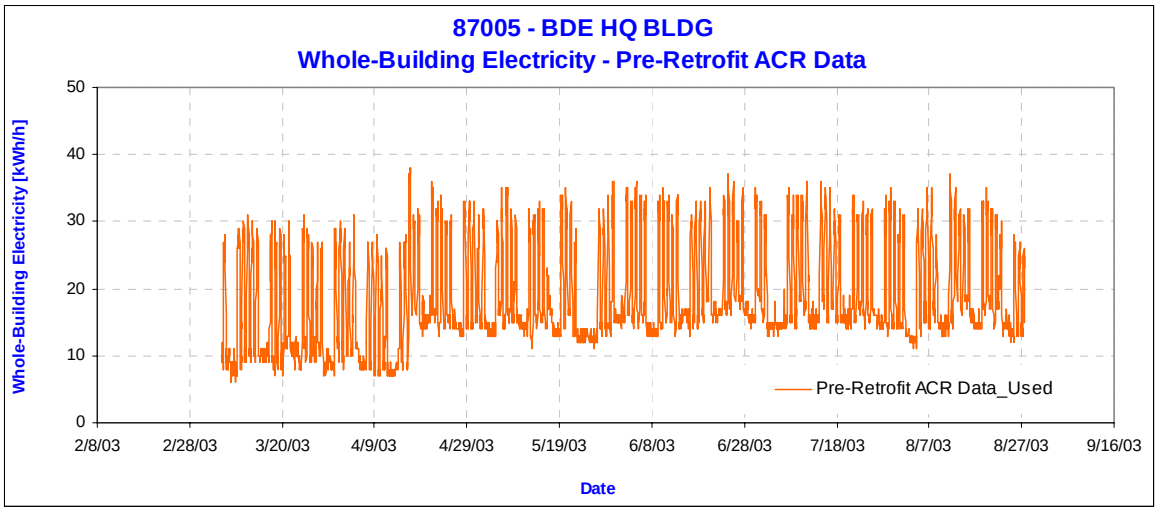

Figure 19.5. 87005 Hourly ACR Data for the Pre-Retrofit Period (March 2003 to August 2003)

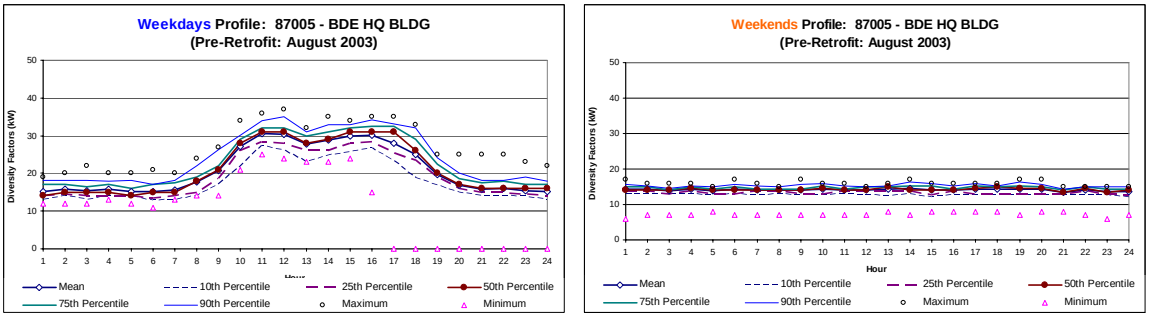

Figure 19.6. 87005 Electrical Demand Model for Pre-retrofit Period

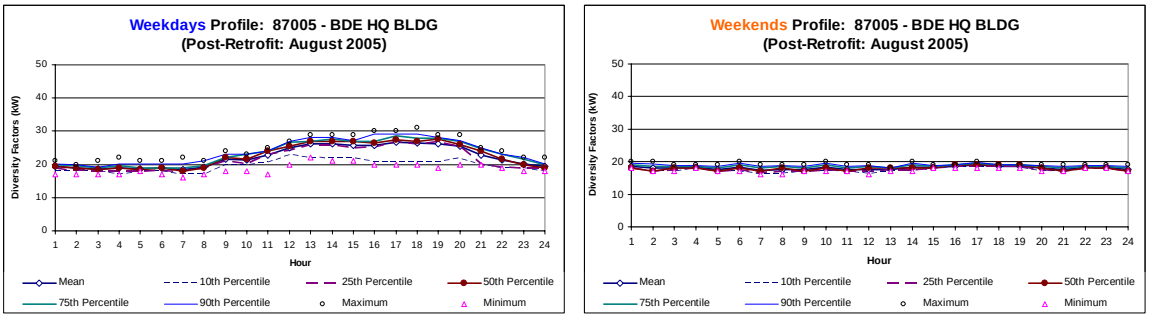

Figure 19.7. 87005 Electrical Demand Model for Post-retrofit Period

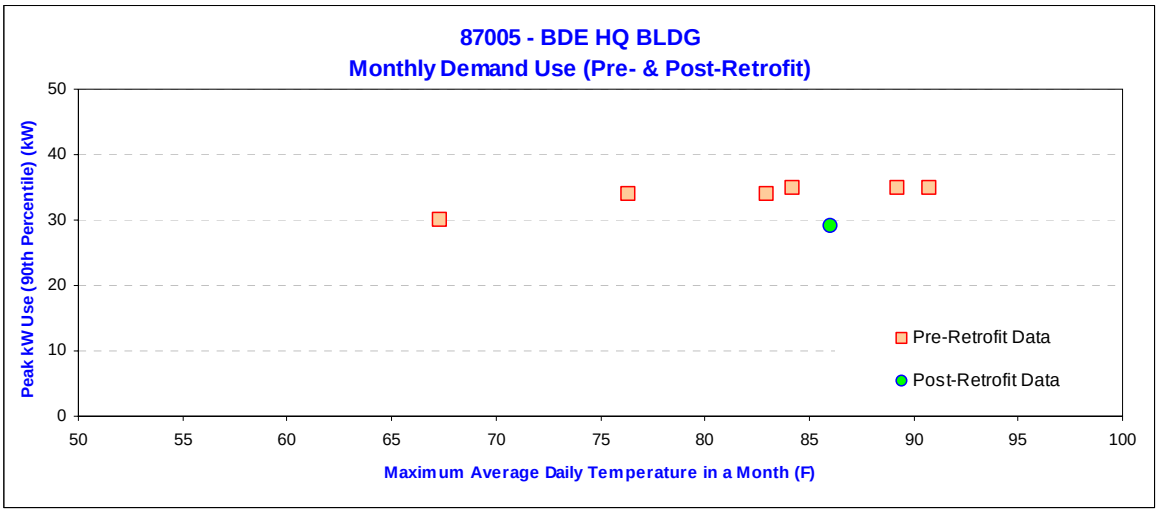

Figure 19.8. 87005 Electrical Demand Use for Pre- and Post-retrofit Periods

20. SAVINGS SUMMARY FOR 33001-MEDAC

This section covers the energy and demand savings report for 33001-MEDAC of Fort Hood for the period of January 2005 – July 2005. According to the information obtained from Fort Hood, lighting and vending miser retrofits were implemented at this site. The lighting project was completed in December 2004 and the vending miser project was completed in March 2004. The audit-estimated savings were 38,406 kWh/yr for electricity and 138 kW/yr for electrical demand. As shown in Table 20.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity savings of 69,019 kWh for a total of 7 months correspond to 309.4% of the audit estimated savings. This indicates that the retrofits are working better than expected at this building. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 20.1 shows the time series plot of the electricity use of 33001-MEDAC Building for the period of May 2003 through July 2005 (utility data) and the average daily electricity use from the ACR hourly data for the period of August 2004 to May 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. Due to lack of hourly ACR data in the pre-retrofit period, the monthly utility data collected for the pre-retrofit period were converted to average daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 20.2. The monthly utility data for post-retrofit period were converted to average daily usage and then compared against the estimated average daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 20.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 20.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures were used for demand analysis. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of April 2005 (Post-retrofit), developed from measured data, are displayed in Figure 20.5, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for April 2005 (Post-retrofit) is 113 kW. In Figure 20.6, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the post-retrofit period. Due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 20.1. Savings Summary for 33001

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jan-05	31	14,230	3,262	436.3%
Feb-05	28	13,271	2,946	450.5%
Mar-05	31	10,550	3,262	323.4%
Apr-05	30	10,711	3,157	339.3%
May-05	31	4,909	3,262	150.5%
Jun-05	30	4,725	3,157	149.7%
Jul-05	31	10,622	3,262	325.6%
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**212**	**69,019**	**22,307**	**309.4%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jan-05	31	N/A	11.46	N/A
Feb-05	28	N/A	11.46	N/A
Mar-05	31	N/A	11.46	N/A
Apr-05	30	N/A	11.46	N/A
May-05	31	N/A	11.46	N/A
Jun-05	30	N/A	11.46	N/A
Jul-05	31	N/A	11.46	N/A
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**212**	**N/A**	**80.25**	**N/A**

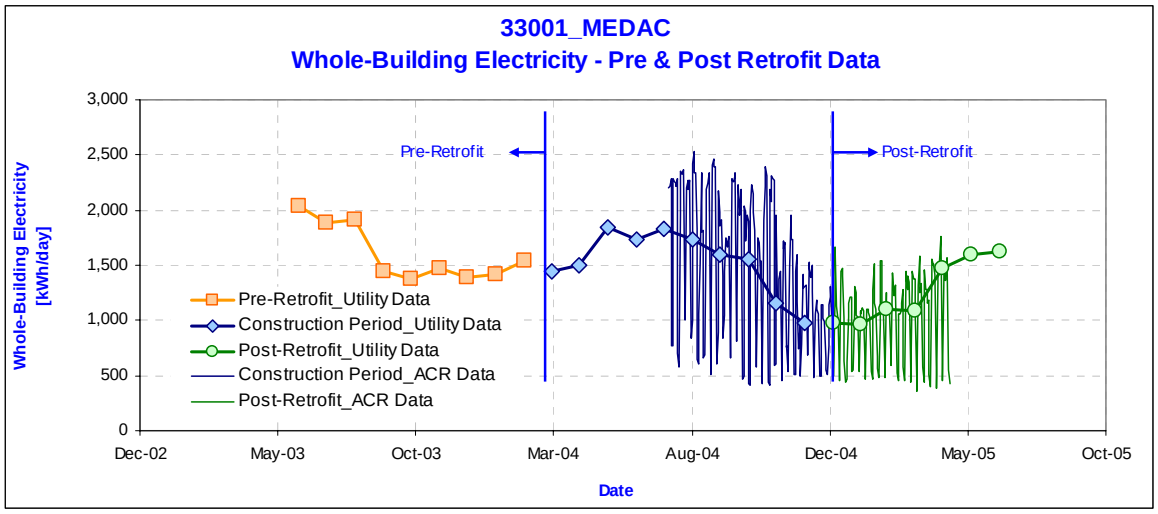

Figure 20.1. 33001 Daily Electricity Use

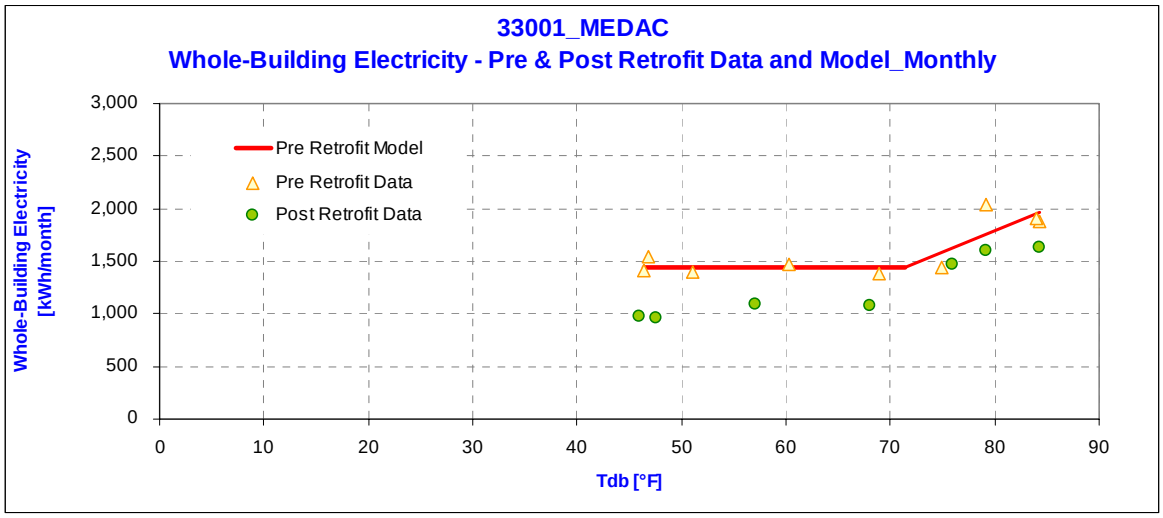

Figure 20.2. 33001 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

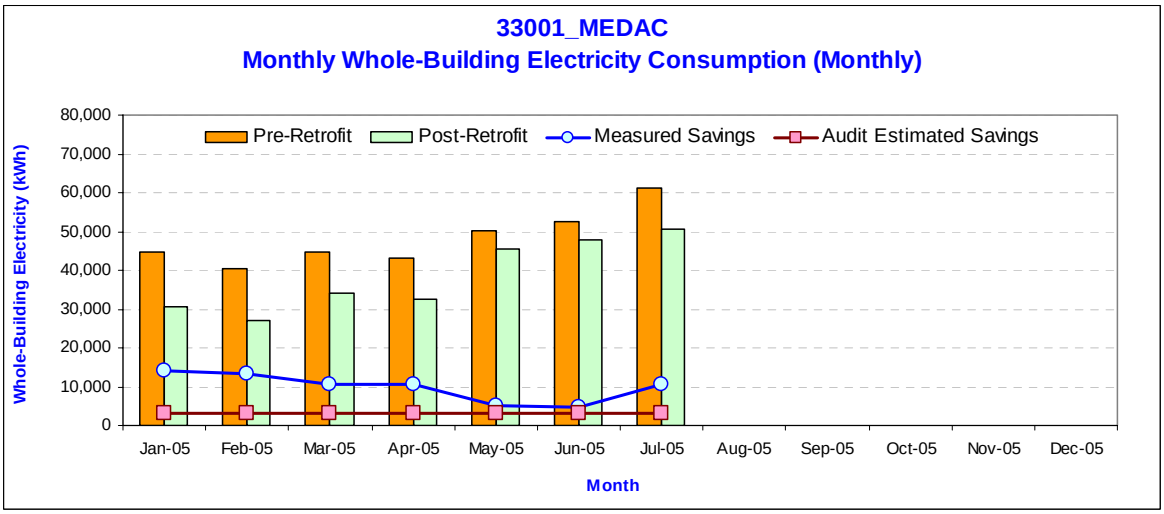

Figure 20.3. 33001 Electricity Savings

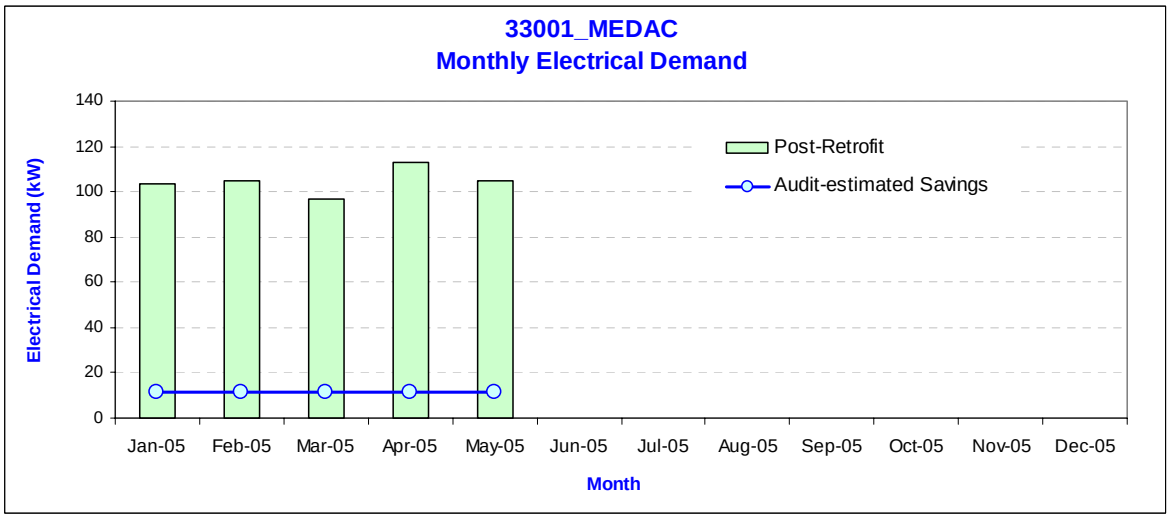

Figure 20.4. 33001 Electrical Demand Savings

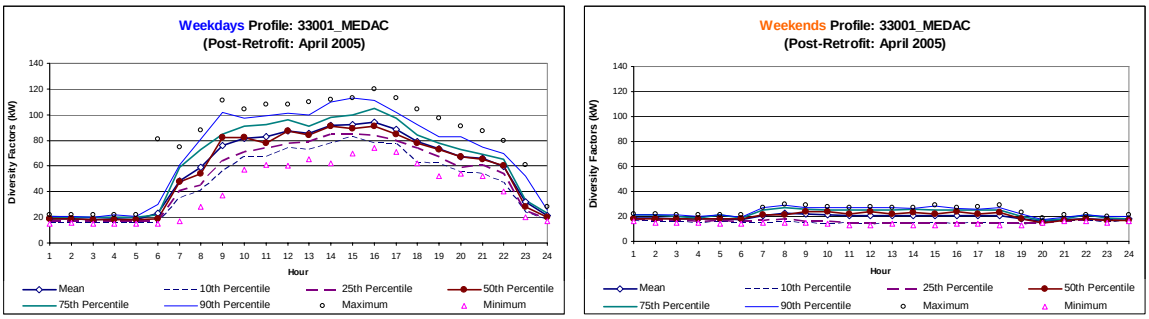

Figure 20.5. 33001 Electrical Demand Model for Post-retrofit Period

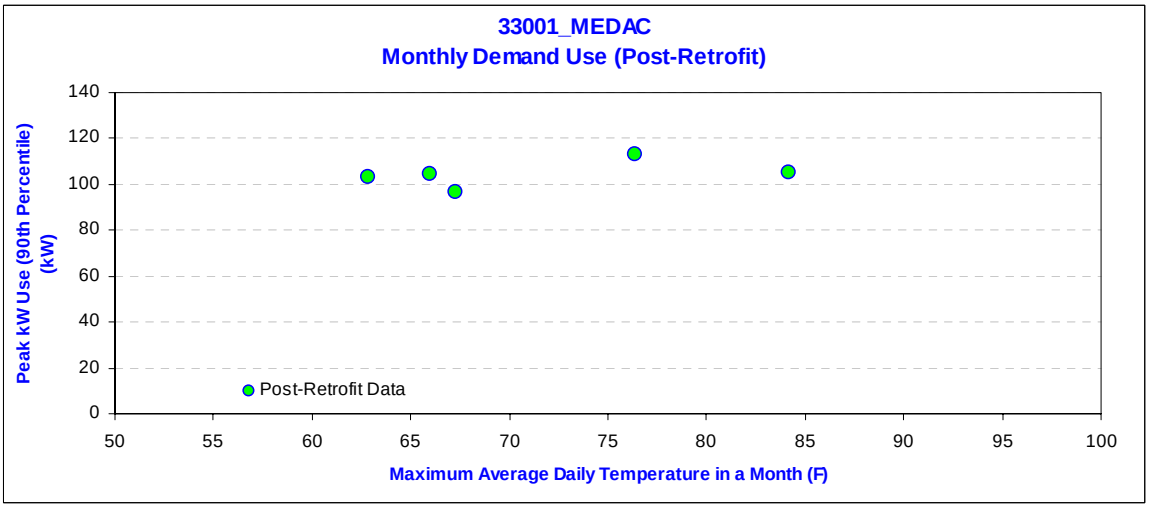

Figure 20.6. 33001 Electrical Demand Use for Post-retrofit Period

21. SAVINGS SUMMARY FOR 33003-MEDAC

This section covers the energy and demand savings report for 33003-MEDAC of Fort Hood for the period of January 2005 – July 2005. According to the information obtained from Fort Hood, lighting retrofit was implemented at this site in December 2004. The audit-estimated savings were 37,754 kWh/yr for electricity and 126 kW/yr for electrical demand. As shown in Table 21.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings are simply the annual savings divided by twelve. The measured electricity consumption savings of -36,228 kWh, for a total of 7 months, correspond to an increase in electricity consumption for the building. This falls short of expectations and may be indicating that there was an operational change. More data are needed from Fort Hood to continue monitoring the savings. The demand savings can not be calculated due to lack of hourly data in the pre-retrofit period.

Figure 21.1 shows the time series plot of the electricity use of 33003-MEDAC Building for the period of May 2003 through July 2005 (utility data) and the average daily electricity use from the ACR hourly data for the period of August 2004 to May 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The monthly utility data collected for the pre-retrofit period were converted to average daily usage and then modeled with ASHRAE's IMT change-point linear model, as shown in Figure 21.2. The monthly utility data for post-retrofit period were converted to average daily usage and then compared against the estimated average daily usage from the three-parameter model to calculate the savings. The electricity consumption for pre- and post-retrofit periods and the electricity savings are presented in Figure 21.3.

The electrical demand for post-retrofit periods and the audit-estimated electrical demand savings are presented in Figure 21.4 The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used for demand analysis. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

Figure 21.5 shows the hourly ACR data used in the demand analysis for the pre-retrofit period. The 24-hour profiles for weekday and weekend of October 2004 (Pre-retrofit) and April 2005 (Post-retrofit), developed from measured data, are displayed in Figure 21.6 and Figure 21.7, as an example to present the demand analysis. The maximum kW use using the 90^{th} percentiles is used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for October 2004 (Pre-retrofit) and April 2005 (Post-retrofit) are 111 kW and 84 kW, respectively. In Figure 21.8, the maximum monthly demand from the 90^{th} percentile profile is plotted against the maximum average daily temperature of the month for the pre- and post-retrofit periods. Due to the missing data in the pre-retrofit period to compare against the same months of post-retrofit period, the demand savings can not be calculated.

A spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings will be included in the final report.

Table 21.1. Savings Summary for 33003

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
Jan-05	31	-8,056	3,206	-251.2%
Feb-05	28	2,906	2,896	100.3%
Mar-05	31	2,770	3,206	86.4%
Apr-05	30	-5,301	3,103	-170.8%
May-05	31	-6,598	3,206	-205.8%
Jun-05	30	-6,795	3,103	-219.0%
Jul-05	31	-15,154	3,206	-472.6%
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**212**	**-36,228**	**21,928**	**-165.2%**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
Jan-05	31	N/A	10.48	N/A
Feb-05	28	N/A	10.48	N/A
Mar-05	31	N/A	10.48	N/A
Apr-05	30	N/A	10.48	N/A
May-05	31	N/A	10.48	N/A
Jun-05	30	N/A	10.48	N/A
Jul-05	31	N/A	10.48	N/A
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Total	**212**	**N/A**	**73.33**	**N/A**

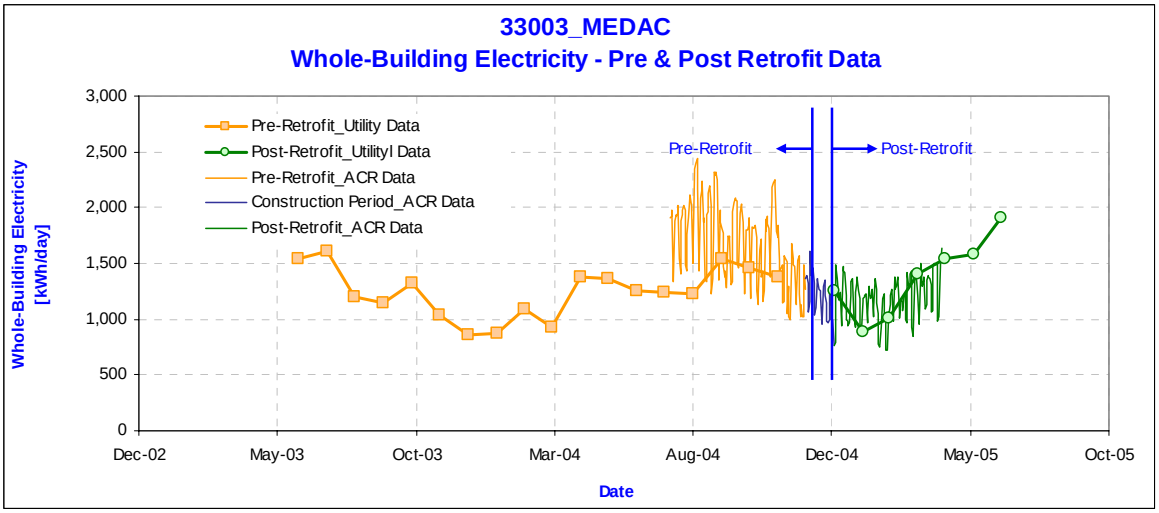

Figure 21.1. 33003 Daily Electricity Use

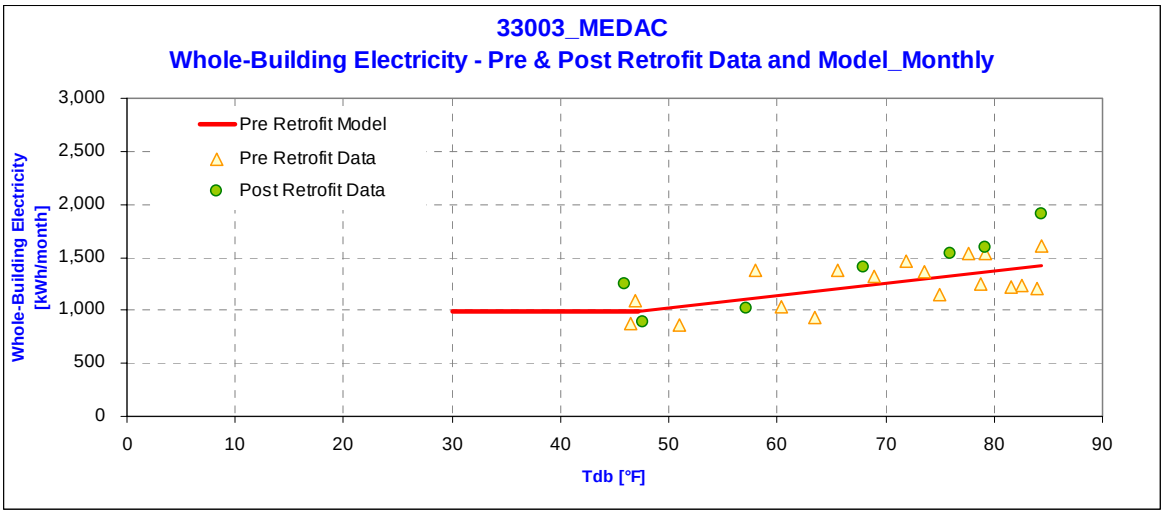

Figure 21.2. 33003 Electricity Models for Weekdays and Weekends for Pre- and Post-retrofit Periods

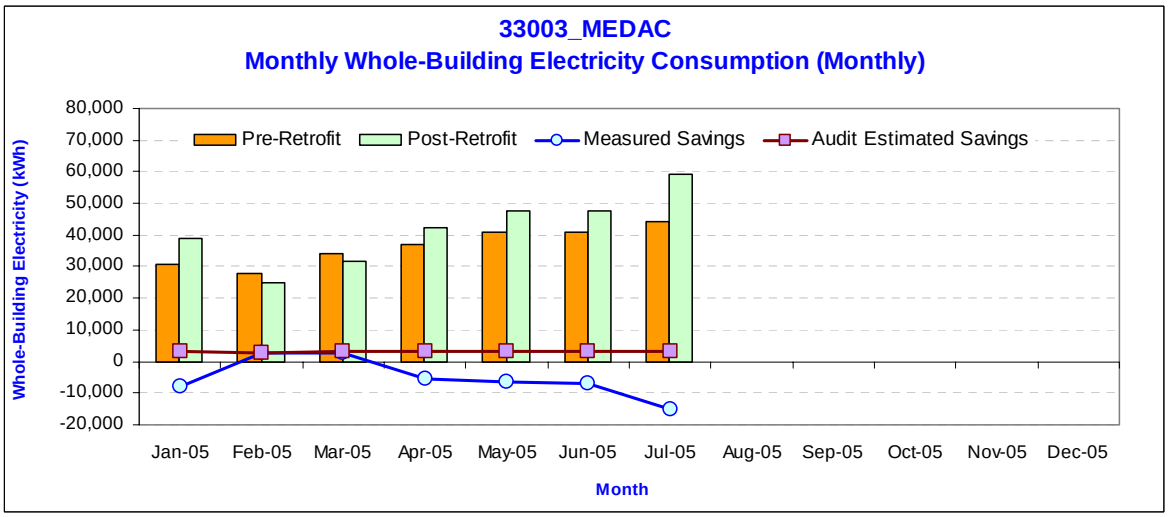

Figure 21.3. 33003 Electricity Savings

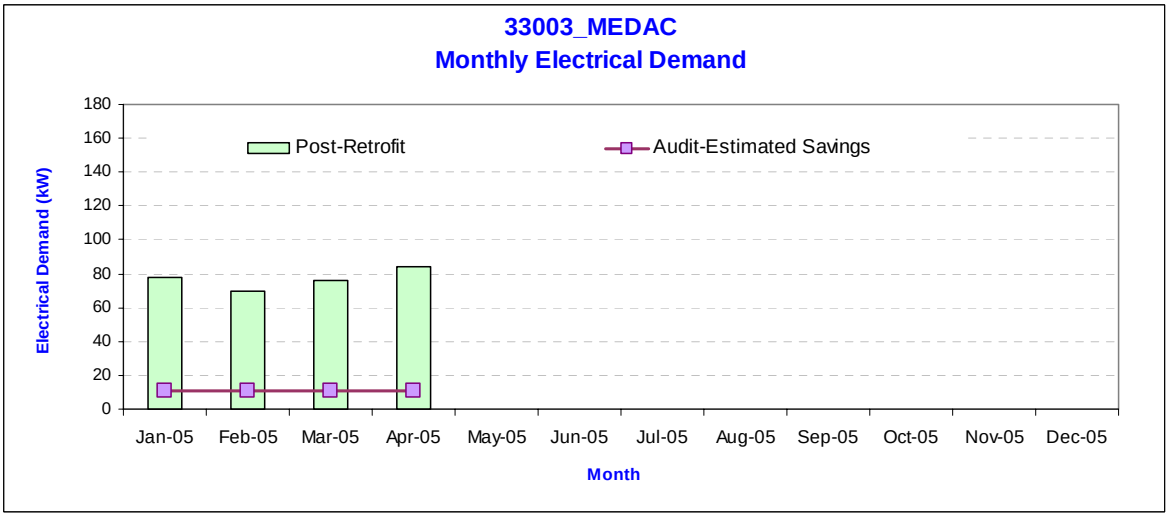

Figure 21.4. 33003 Electrical Demand Savings

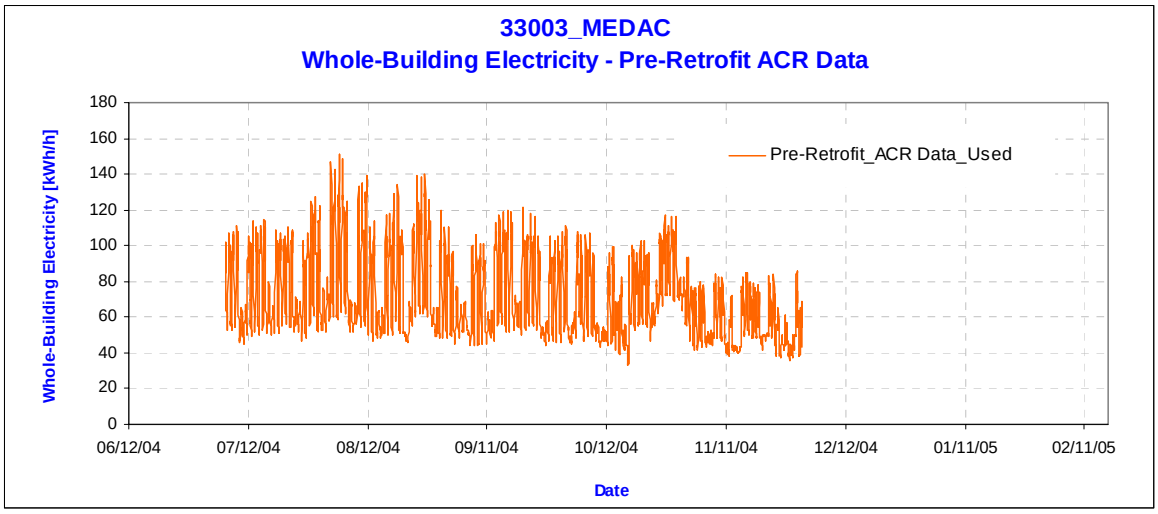

Figure 21.5. 33003 Hourly ACR Data for the Pre-Retrofit Period (July 2004 to November 2004)

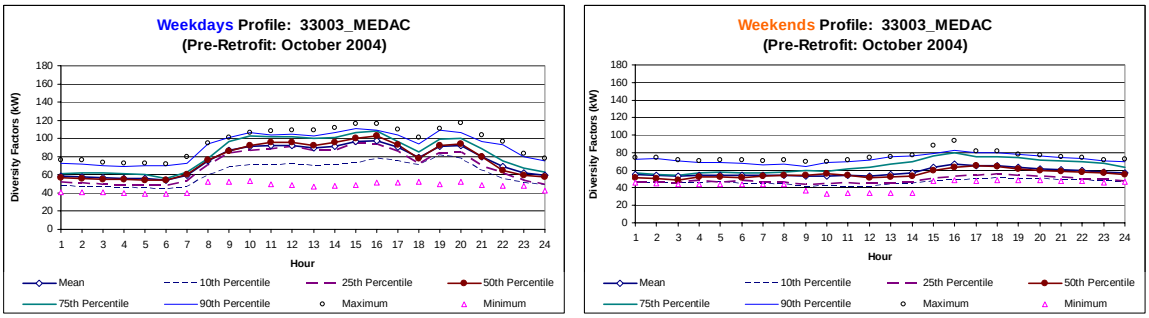

Figure 21.6. 33003 Electrical Demand Model for Pre-retrofit Period

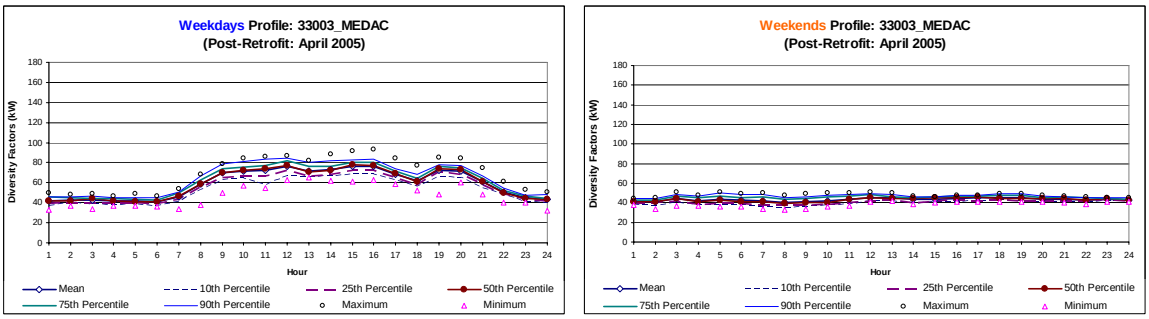

Figure 21.7. 33003 Electrical Demand Model for Post-retrofit Period

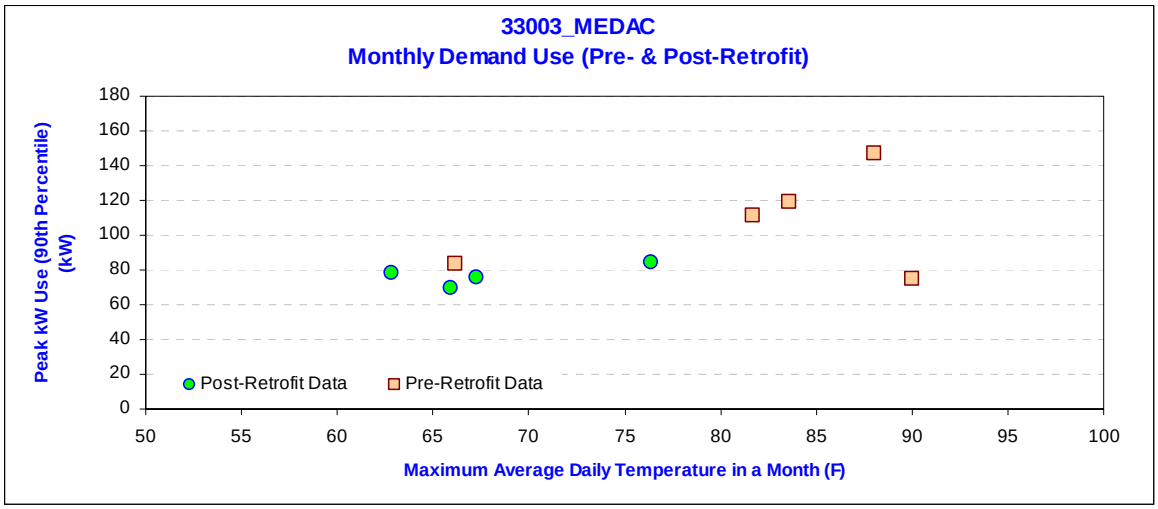

Figure 21.8. 33003 Electrical Demand Use for Post-retrofit Period

22. SAVINGS SUMMARY FOR 87018-87000 BLOCK THERMAL PLANT

This section covers the energy and demand savings report for 87018-87000 Block Thermal Plant of Fort Hood for the period of May 2005 – June 2005. According to the information obtained from Fort Hood, lighting, HVAC controls and cooling tower retrofits were implemented at this site. The lighting project was completed in April, 2004. The HVAC controls retrofit was completed in January 2005. The cooling tower retrofit was completed in April 2004. The audit-estimated savings were 522,971 kWh/yr for electricity and 15 kW/yr for electrical demand. As shown in Table 22.1, the monthly audit estimated savings for electricity is proportional to the number of days per month and the monthly audit estimated demand savings is simply the annual savings divided by twelve. The measured electricity consumption savings of -59,751 kWh and the measured electricity demand savings of -366 kW for a total of 23 days correspond to an increase in electricity consumption and demand use for the site. This falls short of expectations. Additional measured data are needed in order to complete the savings analysis for this site.

Figure 22.1 shows the time series plot of the measured daily electricity use of 87018–87000 Block Thermal Plant for the period of April 2001 through June 2005. The pre-retrofit period, construction period and post-retrofit period are also shown in the plot. The hourly data collected by the synergistic logger for the pre-retrofit period were converted to daily usage and then modeled with ASHRAE's IMT change-point linear models, as shown in Figure 22.2. The hourly data for post-retrofit period were converted to daily usage and then compared against the estimated daily usage from the four-parameter model to calculate the savings. The monthly electricity consumption for pre- and post-retrofit period and the electricity savings for 10 days of May 2005 and 13 days of June 2005 are presented in Figure 22.3.

The monthly electrical demand for pre- and post-retrofit period and the electrical demand savings are presented in Figure 22.4. The weather-independent analysis, which utilizes 24-hour profiles that were developed using ASHRAE's 1093-RP diversity factor procedures, was used to evaluate demand savings. The methodology used to derive the 24-hour weekday, weekend profiles is based on an analysis developed for ASHRAE research project 1093-RP that uses percentiles, where the 10th, 25th, 75th, and 90th percentiles are reported for each hour of the day by daytype (i.e., weekday, weekend).

The 24-hour profiles for weekday and weekend of June 2003 (Pre-retrofit) and June 2004 (Post-retrofit) are displayed in Figure 22.5 and Figure 22.6, as an example to present the demand savings analysis. The 90^{th} percentiles are used to calculate demand savings. In this example, the maximum demand (90^{th} percentiles) for pre- and post period are 520 kW and 631 kW, respectively. Therefore, the savings for June 2005 is -111 kW.

The spreadsheet with all the data collected and detailed analysis and calculation on the electricity and demand savings are available upon request and will be included in the final report.

Table 22.1. Savings Summary for 87018

Electricity:

Month	No. Of Days	Measured Savings (kWh)	Audit-Estimated Savings (kWh)	%
May-05	10	-29,737	14,328	N/A
Jun-05	13	-30,014	18,626	N/A
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
Total	**23**	**-59,751**	**32,954**	**N/A**

Demand:

Month	No. Of Days	Measured Savings (kW)	Audit-Estimated Savings (kW)	%
May-05	10	-254.86	1.29	N/A
Jun-05	13	-111.51	1.29	N/A
Jul-05				
Aug-05				
Sep-05				
Oct-05				
Nov-05				
Dec-05				
Jan-06				
Feb-06				
Mar-06				
Apr-06				
Total	**23**	**-366**	**3**	**N/A**

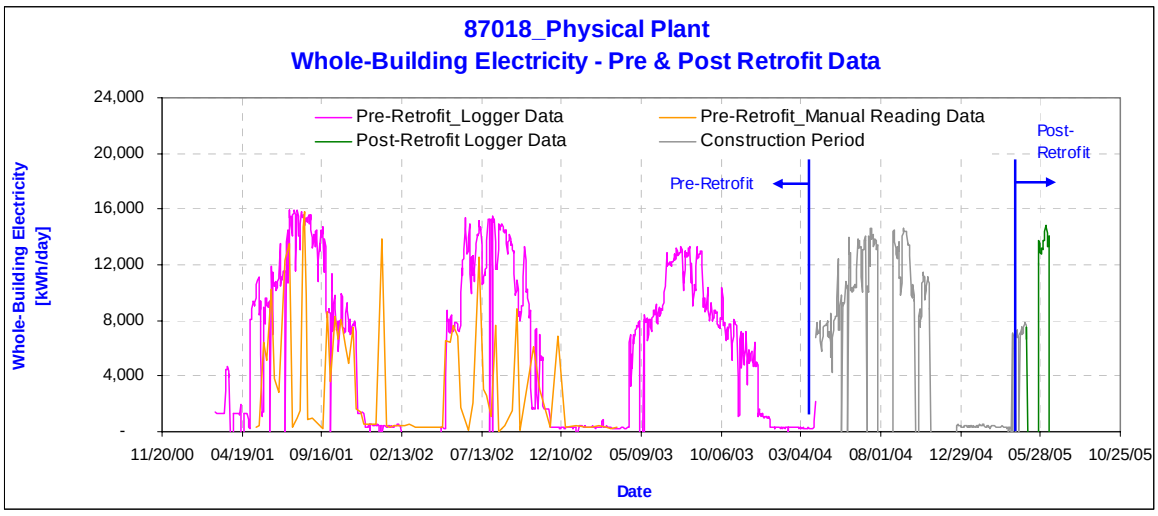

Figure 22.1 87018 Daily Electricity Use

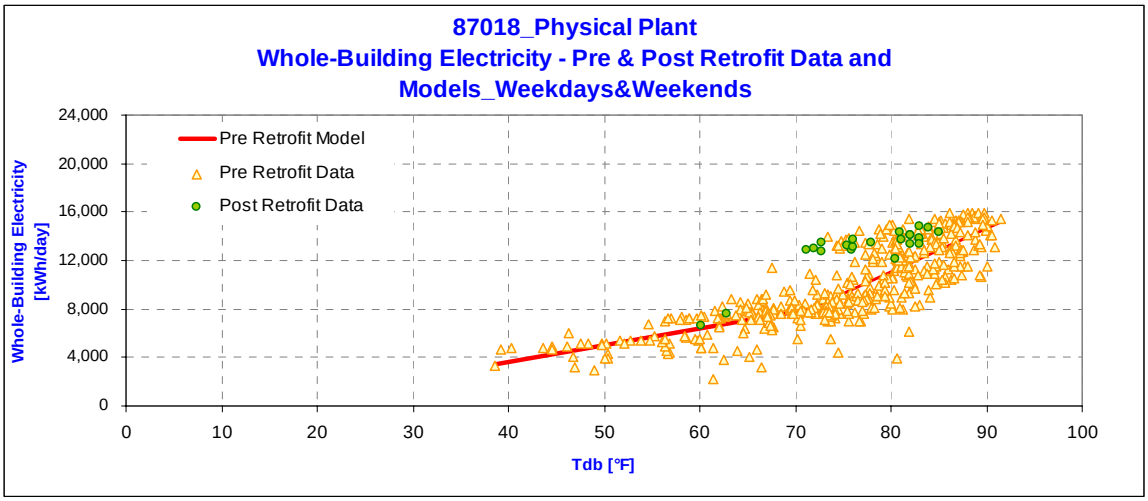

Figure 22.2 87018 Electricity Models for Pre- and Post-retrofit Periods

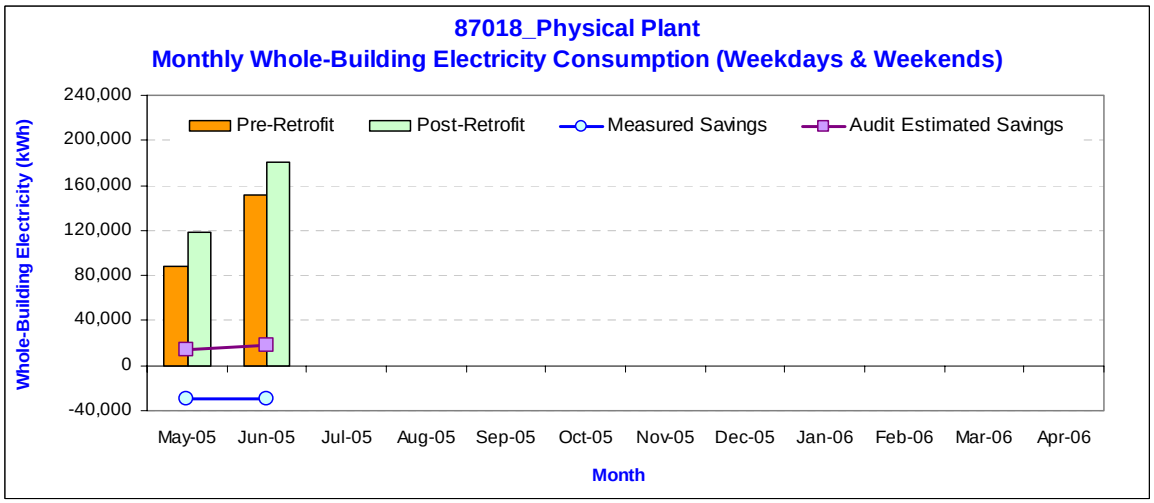

Figure 22.3 87018 Electricity Savings

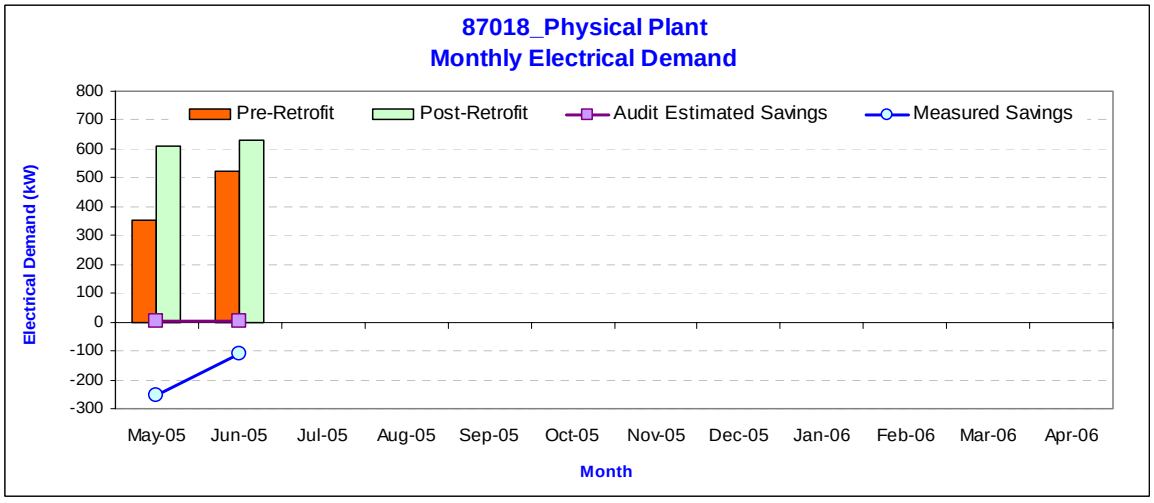

Figure 22.4. 87018 Electrical Demand Savings

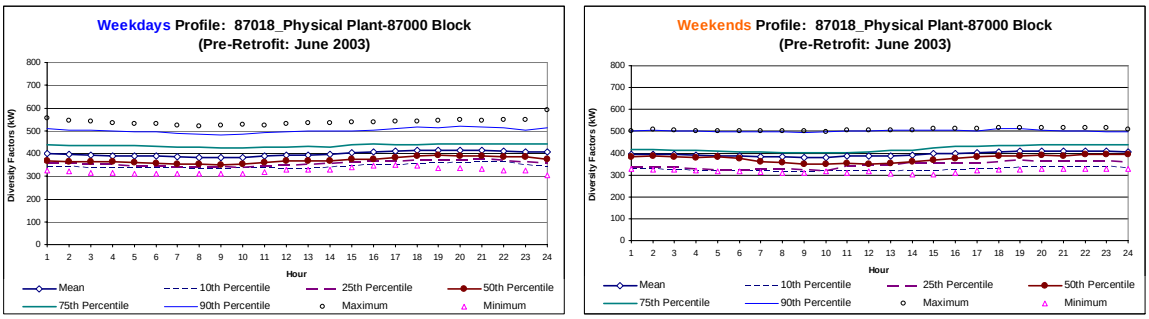

Figure 22.5. 87018 Electrical Demand Model for Pre-retrofit Period

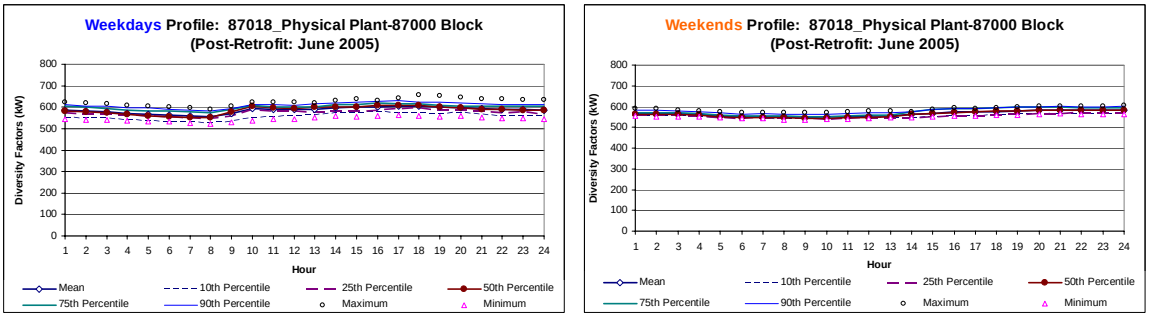

Figure 22.6. 87018 Electrical Demand Model for Post-retrofit Period

23. APPENDIX: LIST OF DATA FILES

In Figure 23.1, the organization of the data files is shown for the CDROM that accompanies this report. This CD contains all data collected to date from Ft. Hood by the ESL and the savings analysis files. In general, these files are organized by logger number, with the exception of the Misc. buildings and 87000 block buildings, which did not have numbered loggers associated with them. The ASHRAE 1050 RP and 1093 RP report and software ordered from ASHRAE for Fort Hood are also included in the CDROM.

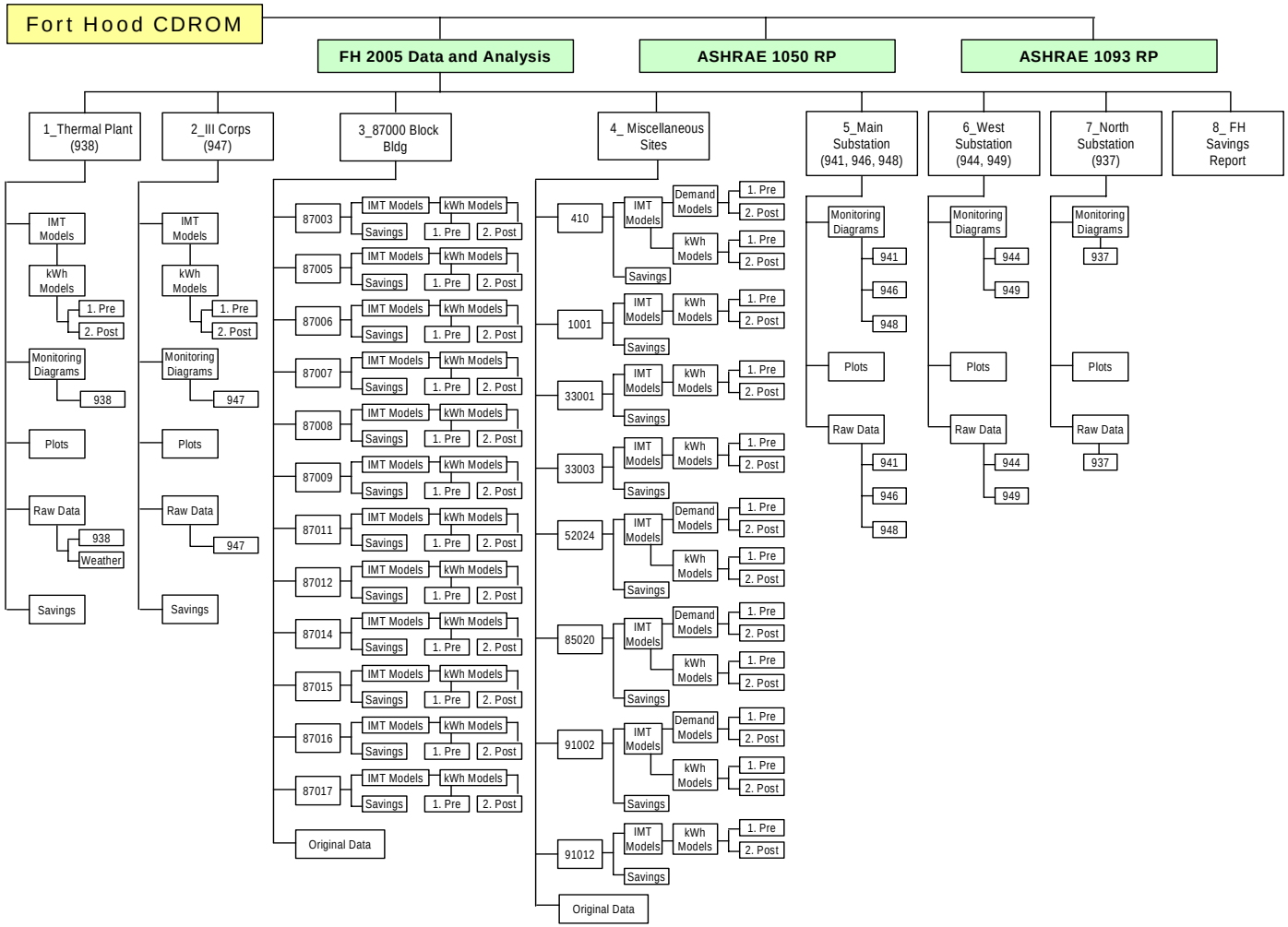

Figure 23.1. Organization of Files on the Accompanying CDROM